PROCEEDINGS OF FARM ANIMAL WASTE AND BY-PRODUCT MANAGEMENT CONFERENCE

UNIVERSITY EXTENSION THE UNIVERSITY OF WISCONSIN NOVEMBER 6 - 7, 1969

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INTRODUCTION

Livestock enterprises are becoming larger and are concentrating many animals in small areas. Cities are growing into the countryside. Because of this, farm animal manure and by-product management has become much more difficult. We need to take a good look at the problems as they now exist, to examine trends and potential future problems, to review research and current practices, and to study possible alternatives for solving this monumental materials handling problem.

Farmers want to know how to manage wastes for most effective utilization and minimum pollution. Local and state governments want to know how to develop educational, technical assistance and regulatory programs. Citizen groups concerned with the quality of our environment want the best possible solutions to these problems.

In view of this interest, this conference was held for technical and administrative staff of local, state, regional and federal agencies; for industries and for private citizens who are concerned about or have a responsibility related to the proper management of wastes from farm animal enterprises in Wisconsin. It was an introductory meeting at which the dimensions of the problems were examined, research was reviewed, some alternative manure handling methods were highlighted, public agency roles were outlined and two existing local programs were described. Small-group discussions explored future program and research needs.

The large attendance and intense interest of the participants showed that the approach was appropriate and interesting for most participants. The formal presentations and summaries of the breakfast discussion printed here give factual information and ideas which will be useful in many ways.

This conference is indicative of what can be accomplished by an inter-agency and interdisciplinary approach to an important environmental problem. We wish to acknowledge with thanks the excellent cooperation of the following agencies and organizations which joined with the University of Wisconsin in planning and presenting various aspects of the conference:

Columbia County, Wisconsin

Southeastern Wisconsin Regional Planning Commission

U.S.D.A. Agricultural Stabilization & Conservation Service

U.S.D.A. Soil Conservation Service

U.S.D.I. Federal Water Pollution Control Administration

U.S.D.I. Geological Survey

U.S.D.I. Public Health Service

Walworth County, Wisconsin

Wisconsin Department of Agriculture

Wisconsin Department of Health & Social Services

Wisconsin Department of Natural Resources

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Marvin T. Beatty -- Extension Specialist Soils, Soil Science Dept., Univ. of Wis. -- Co. Chm.

Theodore J. Brevik -- Extension Agricultural Engineer, Agricultural Engineering Dept., Univ. of Wis., Co. Chm.

John Cain -- Acting Chief, Water Resources Planning Division, Wisconsin Department of Natural Resources, Madison.

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William Q. Kehr -- Bureau of Solid Waste Management, U. S. Public Health Service, Chicago, Ill.

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CONFERENCE PROGRAM

Morning Session -- Nov. 6, 1969 - Richard H. Vilstrup - Presiding

10:30-10:35	Introduction to Conference -- Richard H. Vilstrup
10:35-10:45	INTRODUCTORY REMARKS -- Glenn S. Pound
10:45-11:15	QUANTITIES AND CHARACTERISTICS OF FARM ANIMAL WASTES -- Ralph J. Black and William Q. Kehr

11:15 to 12:15 -- What problems do wastes cause?

11:15-11:30	HEALTH PROBLEMS -- Elizabeth F. McCoy
11:30-11:45	AESTHETICS AND ODORS -- Douglas Evans
11:45-12:00	DEAD ANIMALS AND HOW THEY CONTRIBUTE TO POLLUTION OF THE ENVIRONMENT -- Dr. A. A. Erdmann
12:00-12:15	WATER QUALITY PROBLEMS -- F. H. Schraufnagel

Afternoon Session -- Nov. 6, 1969 - T. J. Brevik - Presiding

1:30-1:45	FUTURE TRENDS IN LIVESTOCK PRODUCTION -- Robert W. Bray
1:45-2:30	WHAT AND WHERE ARE THE CRITICAL SITUATIONS WITH FARM ANIMAL WASTES AND BY-PRODUCTS IN WISCONSIN -- M. T. Beatty, J. E. Kerrigan, and W. K. Porter

2:20 to 3:20 -- Considerations in Selecting Dairy Manure Disposal Systems

2:20-2:35	ALTERNATIVES IN MANURE HANDLING -- E. G. Bruns
2:35-2:50	ECONOMICS OF MANURE HANDLING -- O. I. Berge
2:50-3:05	EQUIPMENT FOR MANURE HANDLING -- L. A. Brooks
3:05-3:20	Discussion

3:45 to 4:45 -- Current Research

3:45-4:10 ENGINEERING RESEARCH ON FARM ANIMAL MANURE -- Clyde Barth

4:10-4:25 NATION-WIDE RESEARCH ON ANIMAL WASTE DISPOSAL -- Jacob D. Dumelle

4:25-4:40 WATER RESOURCES CENTER RESEARCH ON ANIMAL WASTES AND WATER QUALITY -- James E. Kerrigan

Evening Session -- Nov. 6, 1969

6:30-8:30 Dinner and Program. Fred Buelow presiding. Speaker: John L. Skinner -- THERE'S HOPE AHEAD

Morning Session -- Nov. 7, 1969 - Marvin T. Beatty - Presiding

7:30 to 9:00 -- Breakfast & Discussion Groups.
THEME: Where Are We Going in Farm Animal Waste Disposal?
TOPICS:

Dairy Farm Manure Handling
Farm Waste Handling
Feedlot Management
Swine Manure Handling
Poultry Manure Handling
Technical Assistance to Farmers
Water Quality Standards
ASCS Cost-Sharing
Nitrates in Wells & Ground Waters
Lake and Stream Pollution from Manure
Educational Programs
Stream Water Quality
Land Use Planning

9:20 to 10:25 -- Federal and State Programs - Douglas Yanggen - Presiding

9:20-9:35 THE ROLE OF THE FEDERAL WATER POLLUTION CONTROL ADMINISTRATION -- Frank E. Hall

9:35-9:45 TECHNICAL ASSISTANCE AVAILABLE FROM THE SOIL CONSERVATION SERVICE -- Jack Densmore

9:45-9:55 COST-SHARING UNDER THE AGRICULTURAL CONSERVATION PROGRAM -- Kenneth H. Hoover

9:55-10:10 THE REGULATORY ROLE OF THE DEPARTMENT OF NATURAL RESOURCES -- Thomas G. Frangos

10:10-10:25 Discussion

10:25 to 11:15 -- County Programs

10:25-10:40 COLUMBIA COUNTY PROGRAM -- Joseph Tuss

10:40-10:55 WALWORTH COUNTY PROGRAM -- James Johnson

10:55-11:15 Discussion

11:15 to 11:30 -- ROLE OF UNIVERSITY EXTENSION -- Gale VandeBerg

11:30 to 11:45 -- WHERE DO WE GO FROM HERE -- Richard H. Vilstrup

INTRODUCTION TO CONFERENCE

Richard H. Vilstrup*

Welcome to the first State Conference on "Farm Animal Waste and By-Product Management" in Wisconsin. This conference is the product of careful planning and close cooperation by several key state and federal institutions and agencies. We hope it will provide an important base of information for waste and pollution conferences and seminars in the future.

Improvement and understanding of waste management techniques is the goal of the participants in this conference. Several basic conditions, including those that follow, were of concern to the planning committee.

- There is a growing concern for the quality of environment in Wisconsin.

- Wisconsin depends on a strong agricultural economic base, yet it desires the best possible environment for all activities and industries.

- Wisconsin is a leader in the production of milk, meat and animal feed. Nearly half its people work in animal and crop production or related agri-industries and food distribution.

- The management of animals and processing plants influences several aspects of the environment.

- Waste management problems will increase with trends toward specialization, concentration, urbanization and industrialization.

The conference committee focused on present as well as future problems. It is dedicated to identifying opportunities for waste utilization, to finding solutions and to planning together to prevent future problems.

During the next few hours we hope to:

1. identify the resources, expertise and technical assistance available.

2. establish the research base on the subject of waste management.

3. identify the agencies concerned and involved in waste management and determine their role and responsibility for action.

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4. identify and put in perspective the critical problems or opportunities for programs in Wisconsin.

5. evaluate the alternatives for action.

6. select a comprehensive industry-wide strategy.

7. develop a coordinated course of action by individuals and agencies to meet the challenges ahead.

INTRODUCTORY REMARKS

Glenn S. Pound*

There come times in the development of a great nation when the people must, and do, make deep commitments to social, economic and educational causes so they can continue on the way to greatness. For example, a little over 100 years ago, America squarely faced the requirements of developing its economic-social structure and made commitments that were probably more far reaching in their effects than any other commitments it has made. I refer, as you perhaps guess, to the establishment of the agricultural educational system.

By the middle of the 19th century, it was clear that if we were to become a great industrial nation, and nations do not become great without industrialization, we would first of all need to become a great agricultural nation because the bulk of our people were engaged in feeding themselves. It was clear that our physical resources were not without limitation and that these would have to be supplemented with information. And it was clear that to get this information continuous federal aid would be required.

You know the end results. We are the world's greatest agricultural and industrial power. Our national commitments to this end truly constitute one of history's great decisions.

Now, in meeting our problem of 100 years ago we have created a cure that threatens to be worse than the disease. In our progress we have done real harm to our environment. Much of what we have done could not have been avoided in a free society, but much could have. We have had great growth in our population, in our industry and in our agriculture. These growths have been virtually uncontrolled and they are highly interrelated. From all of these there are endless outpourings of waste by-products. We stand at another of history's great crossroads. Where we go from here is what counts. Will we take the right path? Do we have enough national courage to establish the programs required to restore and maintain our environment at a quality level as we did 100 years ago? This should be, and I believe will be, the great academic thrust of the coming generation. Such programs will of necessity place certain inhibitions before population growth, industry and agriculture.

One of the first needs is to create an adequate public awareness of the problems, an awareness which will be translated into public policy and public action. This conference program is one effort in this direction.

In creating the public awareness, we must be very careful lest we base our rationale on pure emotion and there is this danger afield. We

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have voices of uncontrolled emotionalism in our society. We must be academic enough to know that in a complex social and economic environment such as ours, things do not come out all white or all black. We must realize that we must establish priorities and that we are in a trade-off situation. If we obtain one thing, then very likely we will have to give up something else. For example, we cannot hope to maintain a quality environment if we allow our population to go uncontrolled. We cannot maintain our great food affluence without heavy use of fertilizers, pesticides, medical drugs, etc. Which will we have, or in what combination will we have them? We cannot remain on a high animal protein diet without having the problem of animal waste.

It takes real courage, great understanding and tolerance to establish priorities. We must all come to possess these qualities. For example, are we in agriculture courageous enough to ask ourselves if we should continue to escalate the per capita consumption of meat in America? We now consume 114 pounds of beef per capita, some 37 pounds of poultry, and some 65 pounds of pork. Projections for 1975 indicate appreciable escalations in consumption of beef and poultry. Does it need to go on up and up and up? Would we prefer to stablize our animal population and have a lower magnitude of waste disposal problem? We are the most wasteful people in the world, and much of our consumption is wasted instead of eaten. Are we courageous enough to stop such wastefulness and thereby need less animals? These are the kinds of questions courage will force us to answer.

So we need public awareness of the problems. We need education to lay out the alternatives. We need courage to establish priorities. If we have these inputs we can have and maintain a quality environment.

Universities particularly need to train manpower and perform research. Their extension arms need to be greatly reinforced, and Extension is already out front of our research. The College of Agricultural and Life Sciences has singled out environmental problems for prime emphasis in the years ahead. We have established a School of Natural Resources to channel leadership in these areas. This school has a center for resource policy studies, a center for environmental communications, a center of environmental awareness and a center of environmental toxicology. The participation on this program of professors from eight different departments reflect our broad concern and participation. We sense our responsibilities and we are trying to respond to them.

The organizational mechanisms do not have to be created as for 100 years ago. What is needed most is a public commitment reflected in legislative appropriations for the research and extension programs. Without vast expenditures of money we simply cannot reverse the tide.

QUANTITIES AND CHARACTERISTICS OF FARM-ANIMAL WASTES

Ralph J. Black and William Q. Kehr*

By the year 2000 the population of the United States is expected to reach 300 million. The burden of this larger population upon the physical environment will intensify all types of pollution, thus forcing increased pollution control and abatement efforts. Farm-animal wastes contribute substantially to pollution, unless properly managed.

To appreciate the challenge of farm-animal waste management in the United States, we must consider the quantities and characteristics of animal wastes together with changing practices and markets in agriculture, since these are influencing the geographic occurrence and the biological, physical and chemical characteristics of these wastes. As pointed out recently by Loehr, the expanding problem of animal waste disposal is due not only to population growth in the United States but also to an upturn in consumption of beef and chicken.[1] The typical U.S. citizen is demonstrating a growing preference for beef and broilers and a slightly waning taste for pork. The per capita consumption of all meats increased 15% between 1950 and 1966, while that of beef increased by about 34%. At the 1966 consumption ratios, each additional million people will require another 172,000 beef cattle, 24,500 dairy cattle and 433,000 hogs.

The trend to confinement feeding of livestock, with more animals per production unit, is firmly established. Mechanized operations, improved nutrition and production, and controlled disease factors have made it possible for livestock producers to handle more animals with a minimum increase in labor. Although livestock production is expected to expand in the future, the number of feeding operations is expected to decline. The result will be more animals per farm. Therefore, it can be expected that the pollution-related problems associated with the handling, treatment and disposal of wastes from these units will be magnified in the future.

An indication of the relative importance of agricultural wastes was given in a categorical breakdown in a 1968 report by the California State Department of Public Health (Table 1).[2] The California study also developed some interesting waste generation data. Chickens (fryers)

* Bureau of Solid Waste Management,
U. S. Public Health Service.

[1] Loehr, R. C., Animal Wastes--a national problem, presented at American Society of Civil Engineers Environmental Engineering Conference, Chattanooga, Tennessee, May 13-17, 1968.

[2] California State Department of Public Health, status of solid waste management; California solid waste planning study; interim report, v. 1., 1968, 270 p.

generate 4.5 tons manure per 1,000 birds; hens (layers) generate 47 tons per 1,000 birds; hogs generate 1.75 tons per head; beef cattle (feedlot) generate 7.5 tons per head; and dairy cattle generate 13 tons per head.

If disposed of improperly, agricultural wastes may pollute water supplies. In addition to weight, the strength and character of wastes are important considerations related to water pollution. When organic material such as animal manure or human sewage is discharged to a stream, the dissolved oxygen level of the water is reduced. Because fish and other desirable forms of aquatic life cannot survive without dissolved oxygen, it is a good indicator of water quality. By comparing the biochemical oxygen demand (BOD) of a waste with that of sewage and knowing the quantity generated daily, the population equivalent (PE) of a waste can be calculated.

TABLE I

SOLID WASTE GENERATED IN CALIFORNIA IN 1967*

WASTES	WEIGHT (tons)	TOTAL WEIGHT
Municipal		
Residential	8,866,000	
Commercial	9,717,000	
Demolition	2,988,000	
Special	1,343,000	22,914,000
Agricultural		
Manure	21,809,000	
Fruit and Nut Crops	2,361,000	
Field and Row Crops	10,731,000	34,901,000
Industrial		
Food Processing	2,127,000	
Lumber	7,993,000	
Chemical and Petroleum	464,000	
Manufacturing	3,103,000	13,687,000
	1967 Total	71,502,000

* Source: California State Department of Public Health. Status of solid waste management; California solid waste planning study; interim report. v.1. 1968. p.II-6.

In 1964 Taiganides reported the following population equivalents for farm animals: 1.9 for hogs, 16.4 for cattle, and 0.014 for chickens (1.4 for 100 chickens).[3] Applying these figures to the 1961 population of swine, cattle and chickens, Taiganides noted that the waste from these animals was equivalent in pollutional effect to 10 times that of the nation's population.

Wadleigh recently examined the agricultural waste problem and concluded:

> Domestic animals produce over 1 billion tons of fecal wastes a year. Their liquid wastes come to over 400 million tons. Used bedding, paunch manure from abattoirs and dead carcasses make the total production of animal wastes close to 2 billion tons. In fact, waste production by domestic animals in the United States is equivalent to that of a human population of 1.9 billion.
>
> As much as 50% of this waste production may be produced in concentrated supply.[4]

The nutrient content of animal wastes is of interest because of its traditional value in stimulating plant growth. Taiganides and Hazen reported on major fertilizing elements in animal excrement.

TABLE 2. GUIDE VALUES FOR AVERAGE DAILY MANURE PRODUCTION AND COMPOSITION*

		Animals		
Item	Units	Hens 4-5 lb	Swine 100 lb	Cattle 1000 lb
Wet manure	lb/day	0.25	7.0	64.0
Total solids	% wet basis	29.0	16.0	16.0
Volatile solids	% dry basis	76	85	80
Nitrogen	% dry basis	5.6	4.5	3.7
P_2O_5	% dry basis	4.3	2.7	1.1
K_2O	% dry basis	2.0	4.3	3.0

*Source: Taiganides, E. P., and T. E. Hazen Properties of farm animal excreta. Transactions of the American Society of Agricultural Engineers, 9(3): 374-376, 1966.

[3]Taiganides, E. P. In Proceedings; National Conference on Solid Waste Research, Chicago, Dec. 1963. Special report no. 29. American Public Works Association, 1964. p. 39-50.

[4]Wadleigh, C. H. Wastes in relation to agriculture and forestry. Misc. Publication No. 1065. U.S. Department of Agriculture, Washington, U. S. Government Printing Office, 1968. p. 10.

TABLE 3. MAJOR FERTILIZING ELEMENTS OF THE COMPLETE ANIMAL EXCREMENT PER 1000 LB OF LIVE ANIMAL WEIGHT*
(Based on Table 2)

	Hens		Swine		Cattle	
	lb/day	lb/yr	lb/day	lb/yr	lb/day	lb/yr
Wet manure	56	32,200	70	22,400	64	20,600
Total mineral matter	3.9	1,400	1.8	600	2.1	800
Organic matter	12.2	4,400	9.4	3,400	8.2	3,000
Nitrogen (N)	0.93	333	0.50	185	0.38	138
Phosphorus (P_2O_5)	0.69	253	0.26	110	0.11	41
Potassium (K_2O)	0.34	118	0.48	172	0.31	112

*Source: Taiganides, E. P., and T. E. Hazen Properties of farm animal excreta. Transactions of the American Society of Agricultural Engineers, 9(3): 374-376, 1966.

At present, the utilization of animal waste for its fertilizing value is economically unfeasible. The much greater increase in production possible with high strength commercial fertilizers results in a much greater yield per cost ratio than can be obtained with animal wastes even when the only cost for the wastes is the expense of handling and spreading. Loehr pointed out that, although man has been using land disposal for thousands of years, his interest has been in crop response "but little data has been accumulated on the optimum amounts of material that can be placed on land when used only for disposal, on land disposal of wastes with different qualities, on subsequent pollution that may occur and on changes in soil conditions that may result." [5]

An actual study of sewage sludge rather than animal wastes is now in progress at the University of Illinois Agronomy Department, under the direction of Dr. Thomas Hinesley for the Metropolitan Sanitary District of Greater Chicago. This is a demonstration grant project funded by the Environmental Control Administration's Bureau of Solid Waste Management. Objectives of the study are to determine the agricultural benefits and environmental changes resulting from the use of digested sewage sludge on field crops, and to develop criteria for the economic and physical characteristics needed in selecting disposal sites.

[5] Loehr, Animal Wastes--a national problem.

England is experiencing animal waste problems similar to those in the United States. Gowan in reviewing the situation for the National Farmers' Union of England and Wales, states:

> What can the farmer do with all these problems to find some sort of solution both now and in the future? There is no doubt that the ideal solution of the animal waste problem is disposal on to farm land. Farmers are being encouraged more and more by the Ministry of Agriculture and the National Farmers Union to turn to the land if this is at all possible. This often means an increased use of straw and a return to more traditional methods of farming. Where this is not possible, the next best solution is inexpensive treatment of the liquid portion with solid disposal on the farm itself. [6]

In our own country, we can conclude that the quantity of animal wastes will increase. This is in response to the consumer demands of a growing population and a demonstrated preference for beef and broilers. The trend to confinement feeding of livestock will result in fewer feeding operations with an increasing number of animals per farm. The management problems associated with the handling, treatment and disposal of animal wastes will be magnified in the future.

[6] Gowan, D. J. B. The National Farmers' Union; a decade of problems. Special Report 1168/69. June 5, 1969. p. 5.

HEALTH PROBLEMS

Elizabeth McCoy*

Animal feces contain enormous numbers of the same kinds of pollution bacteria that are found in human feces and sewage. If the bacteria from animal sources were to find their way into either surface or well waters, which were then tested by the standard bacteriological analysis, such water would be reported as "contaminated" and justifiably so. It is important to know what happens to these bacteria in the handling of manure.

From counts made on the fresh feces of 12 cows in the University herd, the following numbers of the principal pollution bacteria were obtained:

<u>Coliform</u>

Total on EMB plates	100,000-1,000,000/gm.
True *E. coli*	at least 9.5 x 100,000 or 95+% of total

<u>Enterococci</u>

Total on M plates	1,000,000-10,000,000/gm.

Streptococcus bovis dominates

Streptococcus faecalis group present but in minor numbers

Note that detection of *S. bovis* might be used to differentiate animal source of enterococci vs human source (where *S. faecalis* dominates).

Experiments were done to trace pollution bacteria in manure applied to soil. A first experiment involved soil columns set up on the lysimeter principle and equilibrated with water to approximate field capacity. Then a manure/water suspension of *E. coli* at known population was added and allowed to percolate downward. In a silt loam soil the bacteria with starting counts of a million per milliliter were trapped in the first 8 inches of soil. In sand they passed through 2 feet and still showed 10,000/ml in the water collected.

Another experiment was done under practical field conditions. Five gallon metal pails (with bottoms cut out) were set to about three-fourths of their depth into a field of Miami silt loam. They were set at random for three treatments and controls. One group of three pails received a manure/water slurry in amount to represent 15 tons of manure per acre; a second group received 80 tons per acre — about five times normal farm application; a third group received 15 tons per acre followed a week later

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by an additional 15 ton application; the fourth group were controls with no manure. Counts of coliform and enterococci in the manure slurry used were approximately 1,000,000 and 10,000,000 respectively.

The test was made in early summer under actual farm conditions. By chance, a rainfall of 1.5 inches occurred the night of the second day of the experiment. Because of the raised rim of the pails there was probably little or no run off water, but the rain did probably wash the bacteria from the manure down into the soil (thus giving maximum chance for percolation downward).

Two possibilities were considered in taking samples. The pollution bacteria might have been in large numbers at or near the surface, perhaps even growing because of added nutrient. Or they might have passed rapidly downward and been removed by adsorption onto the soil particles. A core sampler 1 inch in diameter was used to take samples at surface and 2 inch intervals for a total of 30 inches. The bacteriological findings were as follows:

<u>Manure crust</u> (surface)

No growth of either group; numbers $<10\%$ by 7 days; $<1\%$ by 2-3 weeks. Probably drying and sun action contributed to die-off.

<u>Surface soil</u> (just below crust)

Slight growth to approximately 6,000,000/gm. for coliform at three days; not detectable at 3 weeks.

No growth of enterococci at any time; complete die-off by 10 days.

<u>Samples at 2 inch intervals</u>

Very rapid adsorption of both types with $>50\%$ removal in 6 inches of soil; $>90\%$ in 10 inches and $>98+\%$ by 14 inches.

Later samplings at the various levels showed rapid decline of above numbers, interpreted as die-off. Within 10 days the highest coliform counts down to <100/gm. and enterococci not detectable.

A laboratory experiment with manure/water mixture, aerated and confirmed the rapid die-off; $>95\%$ in 5 days for both types of pollution bacteria.

In conclusion we have evidence that both coliform and enterococcus types of pollution bacteria are efficiently removed by adsorption in percolation through soil and by their own die-off because of inability to compete against the established soil and manure microflora. Thus, there is no great concern that they might move any great distance from the point of application of manure or manure water as routinely practiced by farmers.

It is conceivable, however, that surface runoff in early spring or from feed lots could occur and be a serious source of pollution in the watershed. It is also probable that the bacteria could penetrate downward in crevices, sandy or rocky soils or via earthworm holes (this we observed in our experiments). Thus we do not discount the possibility of pollution bacteria moving considerable distances, but our experiments have shown that even at 80 tons/acre on Miami silt loam, the soil acts as a very efficient filter.

AESTHETICS AND ODORS

Douglas Evans*

Aesthetics

Odors can unreasonably interfere with enjoyment of life and property, are capable of nauseating and incapacitating people, and are considered to be public nuisances under these circumstances, even if the substances have no physiological effect.

The difficulty of evaluating the offensiveness of odors is their subjective nature. Individuals have varying thresholds of detection and varying personal response to odors based on age, sex, smoking habits, respiratory abnormalities and occupation. Prolonged and regular exposure appears to raise the threshold of detection. However, for any group of people, as the concentration of odor increases, the odor will eventually be detected and eventually become obnoxious to each person in the group. This is often true even of odors which are normally considered pleasant such as chocolate, roasting coffee and sweet smelling organic solvents.

It can be safely assumed that odors from farm animal wastes, particularly those anaerobically generated are, in general, offensive, but the substances involved and the thresholds of detection are little known.

Odor Thresholds

Any panel of untrained observers allows approximately the normal curve of probability in their detection of an odor. This was found true in sulfur compounds, all of which were organic except hydrogen sulfide, in a range of .03 to 54 parts per billion. Thus, the first of the panel would detect hydrogen sulfide at 1 ppb and the last at 22 ppb.

Typical odor thresholds (ppm by vol.) where all members of trained panels recognize odors are:

Amine, Dimethyl	.047
Ammonia	46.8
Butyric Acid	.001
Dimethylacetamide	46.8
Dimethyl Sulfide	.001
Ethyl Mercaptan	.001
Hydrogen Sulfide	.005
Pyridine	.021
Trimethylamine	.0002

* Wisconsin Department of Natural Resources

Odor Measurement

A standard method for measuring by dilution until an odor-free condition is reached is ASTM Designation D1391-57. In this test, metered amounts of odorous gas are diluted with odor-free air until a threshold is established for each participant. Persons insensitive to odors are eliminated from the panel. The panel then consists of persons whose ability to detect odor is known. Such a panel can be used for field observations.

Conclusion

To control odor problems from farm animal wastes, more needs to be known about the type, quantity and odor threshold of the various compounds involved. From this, better methods of treating, storing, handling and disposing of wastes may be developed which will reduce or eliminate the odor problem.

DEAD ANIMALS AND HOW THEY CONTRIBUTE TO POLLUTION OF THE ENVIRONMENT

Dr. A. A. Erdmann*

In past years the most practical method of dead animal disposal was through the rendering plant. Wisconsin renderers would pick up carcasses and pay a small sum to the owner. Through the years the demand for and the value of products of the renderer such as hides, tallow and meat meal has decreased to the extent the renderer can no longer afford to pay for the dead animals and remain in business. In fact most renderers now charge livestock owners a fee for pick-up and disposal of livestock losses.

The problem is not unique in Wisconsin. A number of our surrounding states, including Michigan, Iowa and Illinois were affected several years before it became a concern in Wisconsin. It appears to be developing into a national problem.

Low prices for the renderer's product is not the only reason for the changing picture. Several other factors bear on the problem.

In 1950 Wisconsin had 24 rendering plants which processed dead animals. A steady decline through the years leaves us with 16 operating plants in 1969. Only 11 of the 16 plants are offering a dead animal pick-up service. The rest process only slaughter plant offal. This, by the way, produces a higher quality product.

Three of our plants are large, modern, continuous rendering operations. One, located in Milwaukee, has a capacity of 70 tons per hour. Unfortunately the continuous rendering process does not lend itself to the processing of deads for several reasons:

- The supply is not uniform.

- Processing deads requires hand labor which is a difficult and costly item these days.

- The rendering process requires part of the grease previously processed to be recirculated to make a slurry. Consequently, one bad carcass lowers the quality of a lot of grease. In contrast, the batch rendering process allows low quality grease to be kept in separate containers. Thus the rendering plant is able to market several grades of grease.

Four rendering plants from outside Wisconsin pick up dead animals within this state by reciprocal agreement with adjacent states.

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Rising transportation costs are common knowledge. Less travel is required to pick up a steady and growing supply of slaughter plant scraps which in turn produce a higher quality product. These factors combine to make the dead animal a problem to the renderers and consequently a problem to the livestock owner.

The number of dead animals being sent to rendering plants has decreased by about 50%. Reports of carcasses being left on premises to rot or to be eaten by wild animals and dogs have increased about 40% over previous years.

Some individuals, unable to provide proper burial or simply trying to avoid the responsibility, are creating a problem for the community. These individuals dump animals on public land or highways. The animals must then be disposed of at public expense by the town health officer. In other cases the dead animals are dumped in neighboring woodlots or pastures where they can spread contagious or infectious diseases to other livestock. We have reports of dead calves and hogs floating down streams and rivers in the spring, the time of year we receive the largest number of complaints.

Present law requires a livestock owner or landlord to dispose of dead animals by burial, rendering or animal food manufacturer, within 24 hours, from April thru November. He has 48 hours to accomplish the task during the rest of the year.

Since January 1969, dead animals have been defined as refuse by Wisconsin Administrative Code, Section NR 51.02, Paragraph 3. If disposal is made by sanitary landfill or incineration, it is regulated by the Division of Environmental Protection. Their purpose is to prevent contamination of the atmosphere and watersheds.

Finding an economic solution to the problem of dead animal disposal does not look hopeful. The U. S. Department of Agriculture reports prices received for tallow are closely related to our export trade. A small gain in export over 1968 resulted in an advance to 7 cents a pound over the low of 4 1/2 cents in July of 1968. Larger quantities of other oils and synthetic materials will keep keen, competitive price pressure on tallow. Price, plus the other factors discussed, will not stimulate renderers to use dead animals.

Finding a solution to the community problem is slightly more encouraging. Assembly Bill 209, which would allow counties to contract with renderers for the disposal of dead animals, has passed the Assembly chamber. The Senate Agricultural Committee concurred with a slight amendment on October 1, 1969. While several townships have taken the initiative and entered into contract with renderers for pickup of all dead animals within the confines of the township, other townships feel they would become islands for dumping dead animals by outsiders and express reluctance for that reason. If counties were allowed to enter into contracts, this problem would be reduced.

Educational efforts by the Extension Service as well as the Department of Agriculture have resulted in the proper disposal of a large number of dead animals. Although this is hard to measure, renderers report they now receive only 50% of the number of dead animals they previously received. Yet the number of complaints we receive has not risen as much as expected.

I would expect the problem of dead animal disposal to increase in the future. The problems of the rendering plant industry, such as added labor costs, collection costs and, perhaps most important, the inferior product resulting from such operations, will probably make it necessary to use a different method of disposal of dead animals than is now followed.

WATER QUALITY PROBLEMS

F. H. Schraufnagel*

Hercules was a famous hero in Greek mythology and was especially noted for his strength. The goddess, Hera, was jealous of his popularity and caused him to be seized with a fit of madness during which he murdered his wife and children. To atone for this terrible deed, Hercules offered his services to undertake "impossible" tasks. He was given 12 labors to perform. His fifth labor was to clean the stable of 3,000 oxen belonging to Aegeas, King of Elis, who had not had them cleaned for 30 years. Hercules directed the courses of two rivers into the stables and cleaned them in a day. Although our problems in animal wastes may now seemingly be approaching Herculean stature, his solution is now called pollution. Looking at it another way, we are now taking over where Hercules left off.

In some states fish kills resulting from pollution by farm animal wastes are a fairly common occurrence. A few years ago, following new developments in cattle raising and fattening, representatives from two midwestern states indicated that feedlot runoff was their state's biggest source of pollution. This is not the case in Wisconsin. We have no record or knowledge of fish kills from animal wastes in this state. This does not infer that we have better control of animal wastes in Wisconsin but rather, I suspect, that up to now we have not been faced with large scale enterprises involving farm animals.

The fish kill pollution situation from animal wastes is typically from the reduction of dissolved oxygen in a surface water. Fish require oxygen to live and propagate. One can expect about 7-9 mg/l of dissolved oxygen in unpolluted surface waters during the summer months. Animal wastes are highly putrescible and in undergoing stabilization can draw heavily on a surface water's oxygen resources. A loss of fish can be expected in the summer months when the dissolved oxygen drops to less than 3 mg/l. Fish cannot survive without dissolved oxygen. The depletion of oxygen and septic conditions can give rise to odors and other offensive conditions in the receiving waters.

A fish kill is a dramatic and usually fairly immediate consequence of severe pollution. However, pollution is often insidious. Pollution from municipalities and industries can usually be pinpointed and measured. Farm animal wastes are most apt to be washed into streams during periods of runoff from diffused or obscure sources. There is usually more conjecture surrounding animal wastes because of the lag between pollution and its effects and the failure to locate point sources.

Probably the biggest concern in Wisconsin about pollution from farm animal wastes is because of their nutrients. Nitrogen and phosphorus are

* Wisconsin Department of Natural Resources

the two nutrients considered significant in excessive fertilization and resultant aquatic nuisances in lakes and streams. Sawyer, in his study of lakes in southeastern Wisconsin, set forth the frequently quoted values of 0.015 mg/l of soluble phosphorus and 0.3 mg/l of inorganic nitrogen as average concentrations, which if exceeded would result in frequent nuisance blooms of algae.[1]

Land disposal of wastes without runoff is usually a very effective way to prevent pollution. Wastes are purified as they move through the soil. Nearly complete removals in the soil of biochemical oxygen demand, phosphorus, bacteria, suspended solids, organic nitrogen and ammonium can be achieved in relatively short distances. However, the latter forms of nitrogen can be oxidized by nature to nitrates. Nitrates move readily through the soil but are also used by plants or may be reduced to nitrogen gas and given off into the atmosphere.

Minshall, Nichols and Witzel reported on a two-year study of nutrients in the base flow of streams in southwestern Wisconsin.[2] Farms occupy about 90% of the land in this area. The average nitrogen content of the base flow amounted to 1.1 lb./acre per year or about 3% of that applied, and the average phosphorus in base flow accounted for 0.1 lb./acre per year or about 2% of that received. The nitrogen represents less than one-fourth and the phosphorus less than one-tenth that lost in the 1967 spring runoff from experimental plots in the area and points out the relative unimportance of base flow as a carrier of plant nutrients.

Some further idea of nutrient contributions to base flow in streams may be obtained from review of chemical data of water supplies. The soluble phosphorus content of 104 well waters in Wisconsin varied from 0.00 to 0.15 mg/l, and the majority of the samples contained less than 0.01 mg/l.[3] The highest nitrogen concentration of a well water found in the state is believed to be a value of 150 mg/l of nitrate nitrogen. This private well was located near a corral.[4] The arithmetic average of 467 public water supplies in the state was 1.2 mg/l and about 5% exceeded 5 mg/l.[5]

[1]C. N. Sawyer, J. B. Lackey and A. T. Lenz, "Investigations of the Odor Nuisance Occurring in the Madison Lakes," Madison, Wisconsin. 1943-1944.

[2]Neal Minshall, M. Starr Nichols and S. A. Witzel, "Plant Nutrients in Base Flow of Streams in Southwestern Wisconsin," Water Resources Research, 5, 3, 706-713. June 1969.

[3]E. C. Hensel, "Soluble Phosphate Content of Safe and Unsafe Well Waters in Wisconsin," B.S. Thesis, Chemistry Department, University of Wisconsin. 1937.

[4]M. S. Nichols (Emeritus Prof. of San. Chemistry), Communications. 1966.

[5]Bureau of Sanitary Engineering with Collaboration of State Laboratory of Hygiene and Wisconsin State Board of Health, "Public Water Supplies of Wisconsin," Madison, Wisconsin. 1935.

A recent article in Science[6] concerned surface water enrichment by ammonia from cattle feedlots. Although this source of nitrogen pollution has generally been ignored, ammonia absorption rates measured near feedlots were as much as 20 times higher than the controls. A lake 2 km. from a large feedlot was said to absorb enough ammonia from the air to increase its nitrogen content by 0.6 mg/l. Nearly all the transfer of ammonia from atmosphere to surface waters was directly by surface absorption and that from precipitation was insignificant.

In addition to a consideration of the potential nutrient contribution of inorganic nitrogen from groundwaters, there is another consideration involved with the nitrates. The Public Health Service Drinking Water Standards recommend that the nitrate concentration not exceed 45 mg/l (equivalent to 10 mg/l of nitrogen) if a better source of supply is available. There is evidence that high concentrations of nitrate might cause methemoglobinemia in infants. A review of the Division of Health records[7] reveals that this disease is lumped with other comparatively rare conditions. There were three to five deaths per year in the overall category from 1963 through 1968. The broad category is split into seven sub-categories, and methemoglobinemia is one of six in a sub-category. There have been no reported deaths from this particular disease during this time period. Records are not available showing the number of cases, if any, that are involved annually.

A review of the data from our network of monitoring stations shows occasional high fecal and total coliform counts in rural areas where there are no significant point sources of pollution. Often these high results coincide with periods of runoff and higher than normal stream flows. Apparently these high bacteria counts are from animal waste runoff. No attempt has been made to evaluate their significance. The biggest threat to water quality now appears to be the use of manure on frozen ground and the substantial amounts that can get into surface water during periods of runoff.

The potential for pollution from animal wastes in this state is tremendous. The cattle and human populations in Wisconsin are similar, but potential cattle pollution is eight to ten times higher. The likelihood of pollution from cattle will increase with manure fluidization and water carriage systems. It is up to us to apply the research, develop the techniques and operate the systems to cope with the problem and maintain water quality. This challenge constitutes a Herculean task indeed.

[6] G. L. Hutchinson and F. G. Viets, Jr., "Nitrogen Enrichment of Surface Water by Absorption of Ammonia Volatized from Cattle Feedlots," Science, Vol. 166, No. 3904, pp. 514-515. October 24, 1969.

[7] R. D. Nashold (Statistician, Division of Health and Social Services), Communications, November 1969.

FUTURE TRENDS IN LIVESTOCK PRODUCTION

Robert W. Bray*

Undoubtedly Wisconsin's future in livestock production must be a major consideration in determining the importance of solid waste disposal or utilization in Wisconsin. Those who believe that waste management associated with Wisconsin livestock production will become less important in the future will not be comforted much by my remarks.

Wisconsin's population and that of surrounding areas has provided a growing market for livestock products. Eighty-five percent of the current cash income from agriculture is derived from livestock and livestock products, and I see no reason for this to decrease in the future. The nature of the bulk of the crop production in the state is especially suited to the support of ruminant animal production and therefore is not directly consumable by humans.

Because of Wisconsin's climate, the state leads all other states in hay production and harvested forages. It is therefore only natural that the cattle population of the state will continue at a high level during the years ahead. Also, the continual increase in corn production for feed grain will support non-ruminant animal production until such time as human food requirements can no longer be met efficiently through the production of pork and poultry. In my opinion this day is still far in the future.

Animal numbers represent only a part of the problem in waste disposal and utilization. Perhaps of more importance are the management systems associated with livestock production. In order to relate the significance of livestock specie and management to the problems of waste disposal, I will give you my thinking and that of several of my associates in the animal science departments within the college.

Wisconsin will continue its dominance in the production of dairy products. Although dairy cattle numbers have decreased in recent years, milk production has remained at essentially the same level. This has occurred at the same time that the national level of milk production has decreased. Thus, Wisconsin's role in national milk production has increased. Milk cow numbers are not expected to decline significantly in the future. Dairy production is widely distributed throughout the state and this distribution pattern will continue in the future except in areas where growth in human population competes more effectively for land use.

Dairy herds of 80 to 100 head are currently economically feasible and will be quite common in the future. Scarcity of labor and the need to replace it with automation has led to many technical advances in housing, milking and feed handling. Many herds are already fed in confinement and

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more confinement feeding is evident for the future. Available harvesting equipment, mechanized manure and feed handling equipment, and greater and more efficient production from crop acres through harvesting by machinery rather than by pasturing will be major factors leading to this increasing trend. Obviously, this practice will add to the problem of manure handling problems from dairy herds.

Beef cattle numbers are on the increase both in the form of beef cows and as feeders in feed lots. Beef cow herds have been traditionally located in southwestern Wisconsin, but are now rapidly increasing in the western and northwestern parts of the state. Wisconsin's forage production, a ready market for feeder calves, and the difficulties encountered in obtaining labor for dairy operations will lead to future increases in beef cow numbers.

The experimental success in the use of low-cost crop wastes such as that associated with corn produced for grain and that of the vegetable industry for the maintenance of beef cows during the winter leads to further speculation that beef cow numbers in Wisconsin will increase in the future.

The economics of confinement feeding of beef cows has not been adequately researched, but it is likely that under some circumstances beef cows will be fed in this manner. Under these circumstances essentially the same waste management problems will be present as in dairy cattle confinement feeding programs.

Over 200,000 head of cattle from feedlots were marketed in Wisconsin in 1968. This represents a record number and all indications are that this number will increase. Beef consumption per capita has doubled over the past 15 years and is now at a record high of 110 pounds. The popularity of beef can lead to 130 to 140 pounds per capita consumption in ten years. This, coupled with an increasing population, could lead to the placement of most of our dairy male calves in feed lots. But the rearing of these calves to the feeder stage can mean an increase in animal populations on many of our dairy farms. The availability of this supply of feeders and corn could lead to a major cattle feeding industry in the state. If this takes place, odors and waste disposal and utilization from the feed lots will resemble those now facing such states as Kansas, Colorado, Iowa and Nebraska.

An increasing production of corn as grain will continue to support a strong swine industry in Wisconsin. Wisconsin ranks about eighth as a state in total swine production and this ranking is expected to continue in the years ahead. The state produces many feeder pigs to be fed out in the corn belt, and also a large number of market hogs. Specialized confinement feeding operations will increase to where it will be common to find 1,000 hog feeding units. Such units may not necessarily produce their own feed supply or have the available land to spread the manure from the feed lots. Thus, we will again be adding to the problem of nuisance odors and waste disposal.

Poultry operations have changed rapidly in recent years. The small farm flock is rapidly disappearing. In their place are specialized egg production units and specialized broiler and turkey farms. The trend is toward bigger and fewer units that utilize new technology, especially in the form of labor saving devices. These operations will resemble those suggested for swine in that large numbers may be concentrated in facilities not associated with any other farm enterprise. Again, the development of large units leads to quite a different problem of waste management than was present when poultry in small numbers was found on virtually every farm in Wisconsin.

Finally, we must not forget to look at the rapidly growing population of horses in this state. Although I cannot provide information of actual increases in light horses and ponies used for recreation in recent years, I am certain you will agree that through observation alone it is apparent that the number is increasing rapidly. Around the periphery of most cities and villages, we now find farm buildings converted into stables or in some cases new facilities for the stabling of horses owned by urban dwellers. Likewise, many urban workers now residing in the country find it virtually essential to own a horse. A horse or two, near one-family dwellings, do not provide major waste disposal problems. However, horse stables housing 25 to 50 animals located near cities can pose odor problems as well as problems in the disposal of manure.

Although there are other animal enterprises in Wisconsin such as sheep, mink, laboratory animals and pets, I do not feel they pose major waste disposal problems. But odor problems with certain of these animal enterprises may be something we will have to direct our attention to.

In summary I believe it is fair to say that (1) livestock numbers will increase in the future and (2) the most economical management systems for all classes of livestock will result in larger numbers and more confinement in each livestock enterprise. Thus, one must conclude that the solid waste management or disposal problems associated with livestock production in this state will become more complex. The College of Agricultural and Life Sciences recognizes the magnitude of this problem and must find the resources to increase greatly its research program on animal wastes in order to find solutions that can be effectively transmitted through University Extension to livestock enterprises in this state.

WHAT AND WHERE ARE THE CRITICAL SITUATIONS WITH FARM ANIMAL WASTES AND BY-PRODUCTS IN WISCONSIN

M.T. Beatty, J.E. Kerrigan and W.K. Porter*

Where and to what extent various kinds of critical situations develop, depends on the interaction of several components of the waste production and management system. These include:

- the kinds and amounts of wastes and by-products produced
- the spatial distribution of the sources
- the proximity to people
- the physical environment -- characteristics of the soils, the landscape, the surface water and groundwater systems
- the uses and demands on water and land resources

A review of these background factors is an important step in planning for action in a state, region, county or a local watershed. To illustrate, let us consider the general situations for a number of these factors in Wisconsin.

FARM ANIMALS

Table 1 shows that most of Wisconsin's large farm animals are dairy cattle and calves. Hogs and poultry are also abundant.

Table 1. Summary of Wisconsin's Livestock Numbers as of January 1, 1969*

Total cattle and calves	4,076,000
Cattle and calves for dairy	3,162,000
Cattle and calves not for dairy	914,000
Feeder cattle	202,000
Hogs and pigs	1,644,000
All sheep	179,000
All chickens and turkeys	7,084,000

*From Wisconsin Statistical Reporting Service.

* Extension Soil Specialist; Assistant Director, Water Resources Center; and Solid Waste Specialist, University Extension, respectively.

Waste disposal problems are usually related to the concentration of animals. The numbers of all cattle and calves per square mile is shown by counties in Figure 1. Areas of especially high concentration include the Fox River Valley, most counties in south central Wisconsin, the Mississippi River counties and counties such as Barron, Dunn and Clark in northwestern Wisconsin. The distribution of milk cows and heifers, shown in Figure 2, follows the same general pattern. The concentration of dairy animals in Calumet, Green, Kewaunee, Brown, Manitowoc and Outagamie counties is especially pronounced.

Hogs are strongly concentrated in Wisconsin's corn belt. Figure 3 shows that the maximum average populations are in Lafayette, Grant and Green counties.

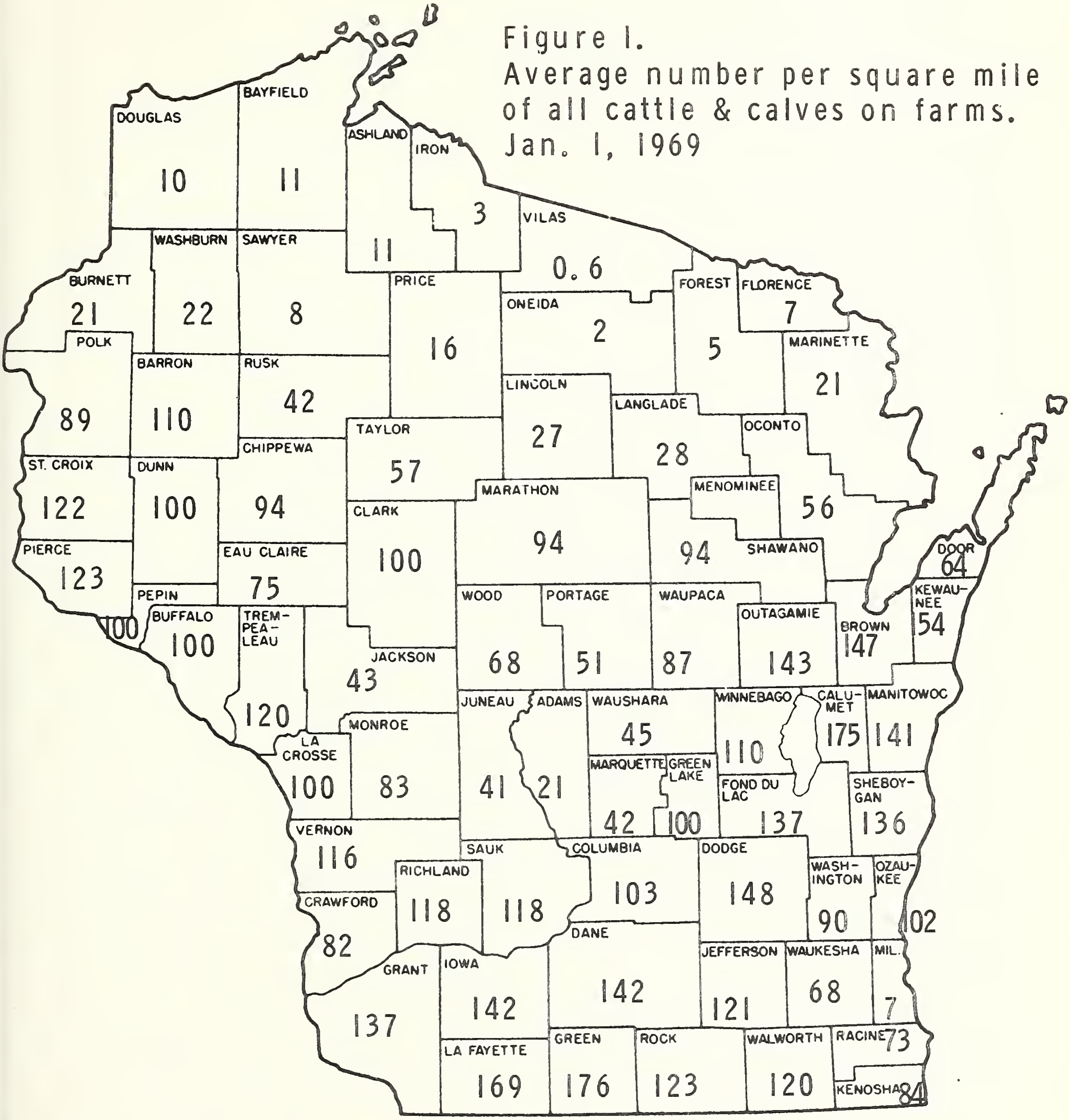
Separate statistics on beef cattle and cattle in feedlots are not available in Wisconsin. This in itself illustrates the limited importance of cattle feeding in the state. Statistics are available on cattle sales per rural square mile in the north central states. In Wisconsin this would represent fed cattle and sale of worn out dairy cows. Predominant dairy counties show about 30 animals sold per rural square mile in 1964; so data on sales are given in Figure 4 for all counties with sales greater than 30 head per rural square mile. This should represent counties in which beef cattle populations are significant, even though the sales figures represent both beef and dairy animals.

Modest numbers of poultry are still widespread on farms, but the really significant waste problems arise when thousands of birds are concentrated in factory type production units. Figure 5 shows these large concentrations in a generalized way. By comparing Figures 5 and 6 it is easy to see that major concentrations of laying hens occur in rapidly urbanizing Walworth, Waukesha and Washington counties. Local problem situations with odors and dust can be expected at this interface between large numbers of people and large numbers of birds.

PEOPLE

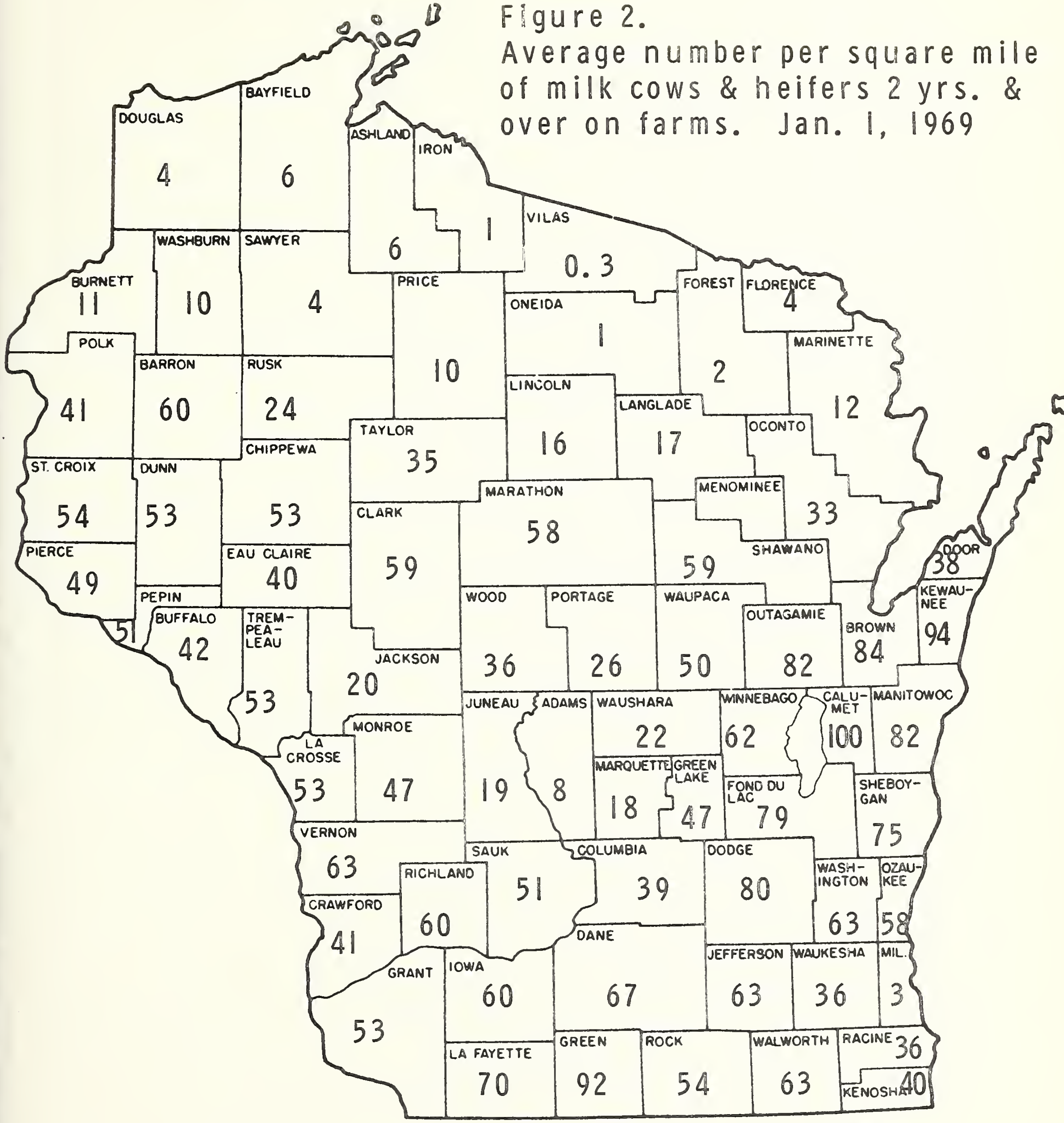
Figure 6 from the 1964 Wisconsin Blue Book, shows the general distribution of Wisconsin's population in 1960. Based on migration trends given in the same volume, it is reasonable to predict that the 1970 census will show: (1) even greater difference between the sparcely populated rural counties of central and northern Wisconsin and the urbanizing counties of the Southeast and the Fox River Valley, and (2) even greater urban sprawl -- the proliferation of urbanizing areas into the countryside.

Figure I.
Average number per square mile of all cattle & calves on farms.
Jan. 1, 1969



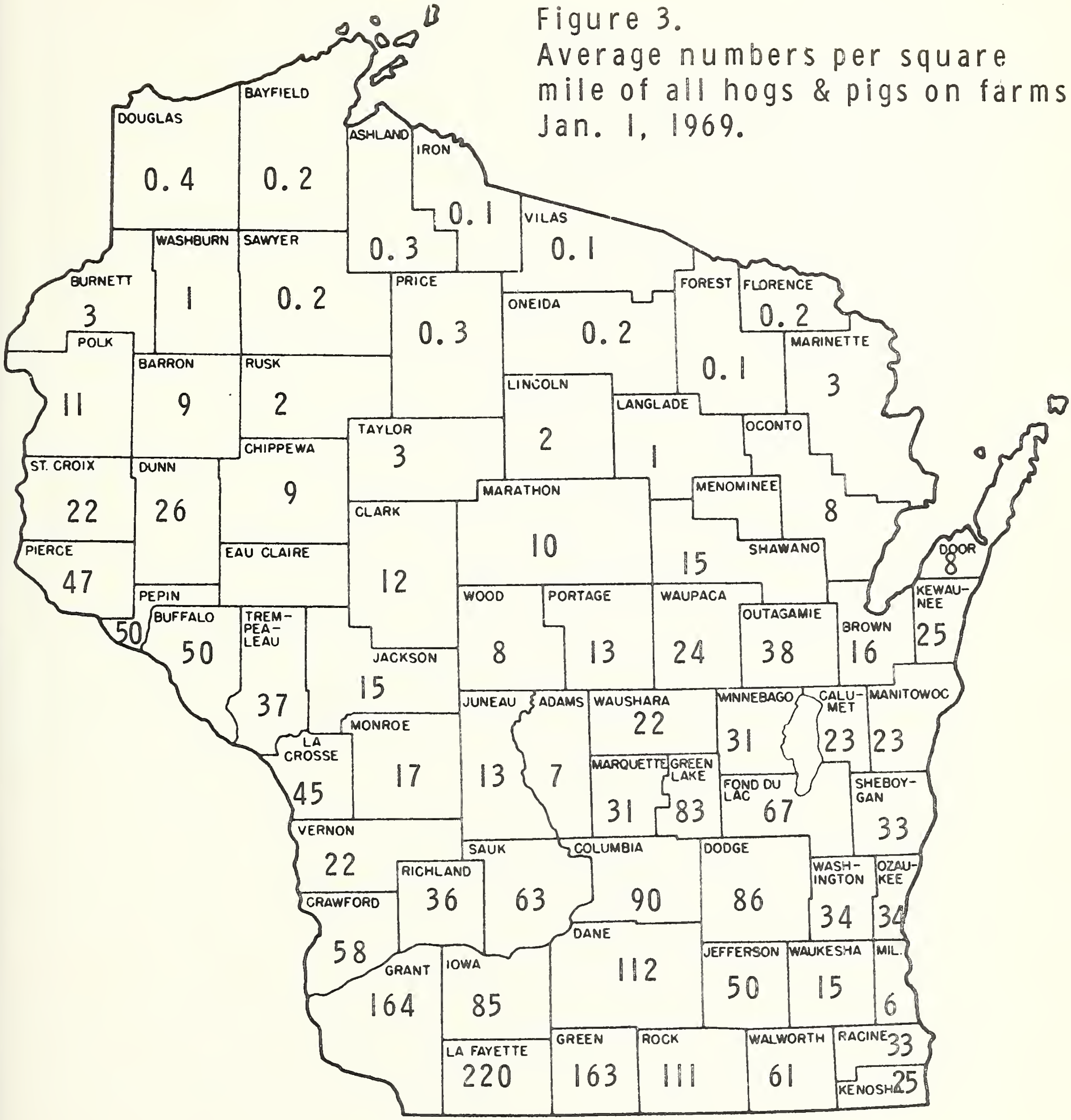
Compiled from Wisconsin Agricultural Statistics, 1969

Figure 2.
Average number per square mile of milk cows & heifers 2 yrs. & over on farms. Jan. 1, 1969



Compiled from Wisconsin Agricultural Statistics, 1969

Figure 3.
Average numbers per square mile of all hogs & pigs on farms. Jan. 1, 1969.



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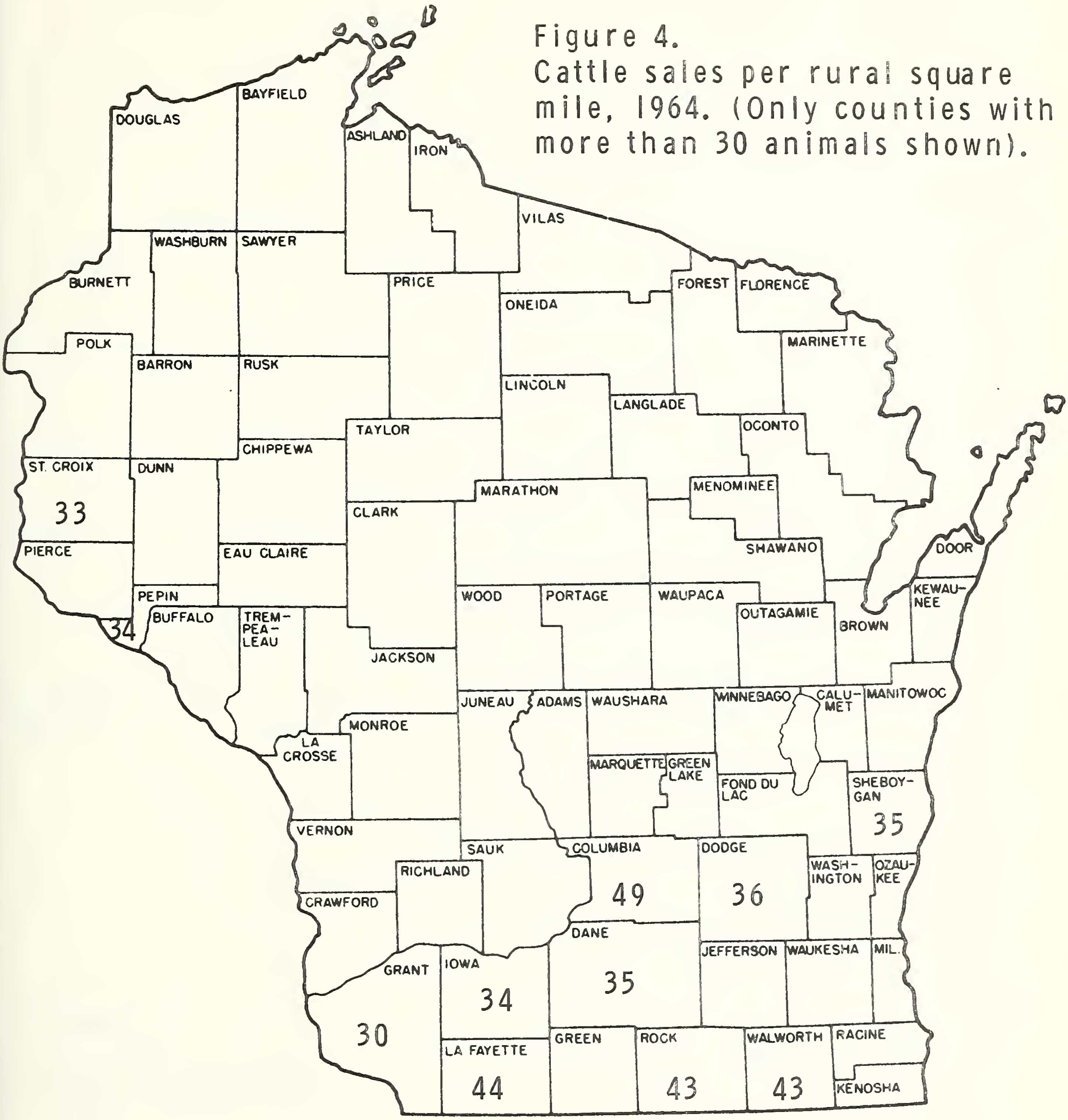
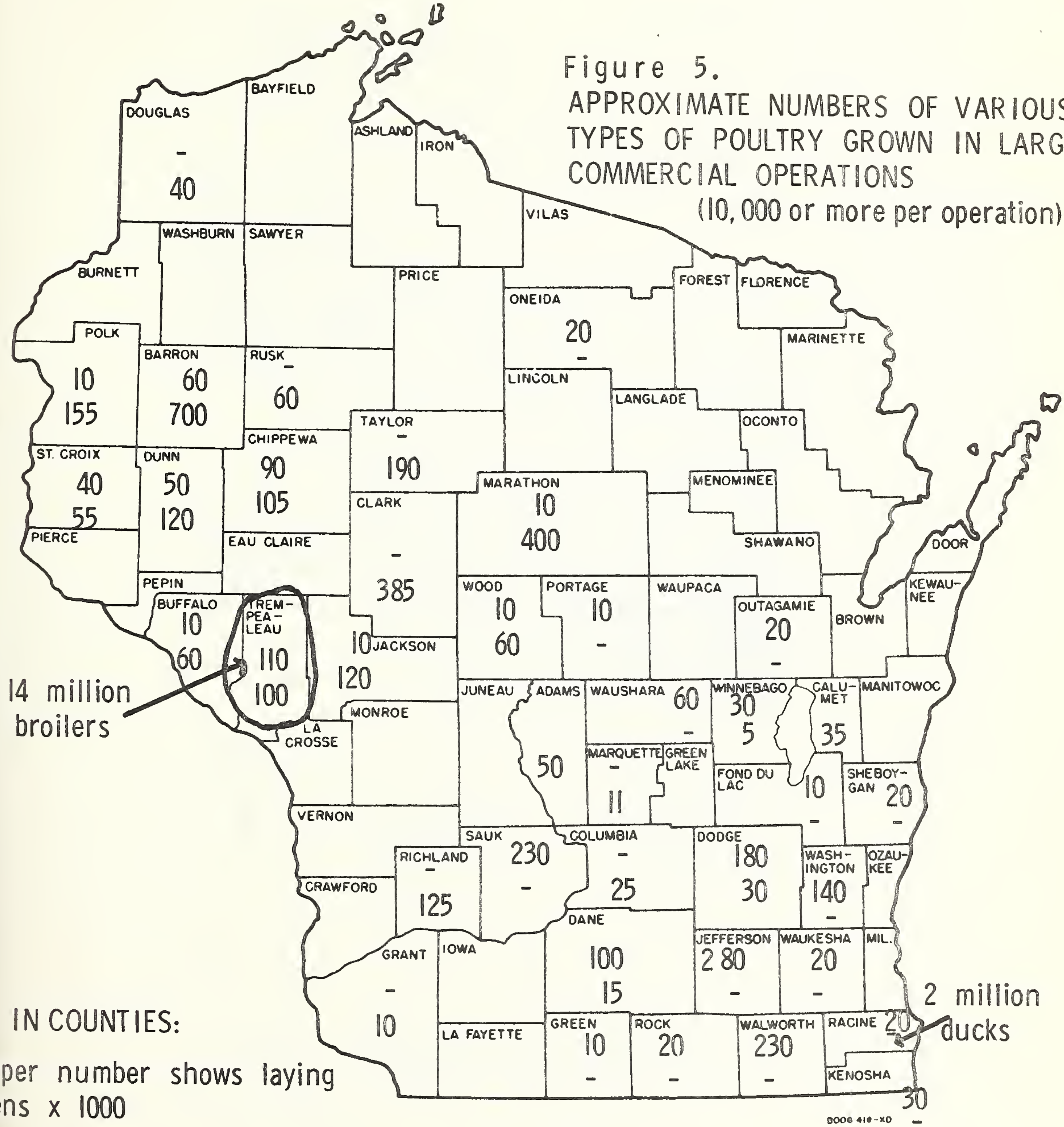


Figure 4.
Cattle sales per rural square mile, 1964. (Only counties with more than 30 animals shown).

Figure 5.
APPROXIMATE NUMBERS OF VARIOUS TYPES OF POULTRY GROWN IN LARGE COMMERCIAL OPERATIONS
(10,000 or more per operation)



IN COUNTIES:

Upper number shows laying hens x 1000

Lower number shows turkeys x 1000

Based on estimates provided by the Poultry Science Department.

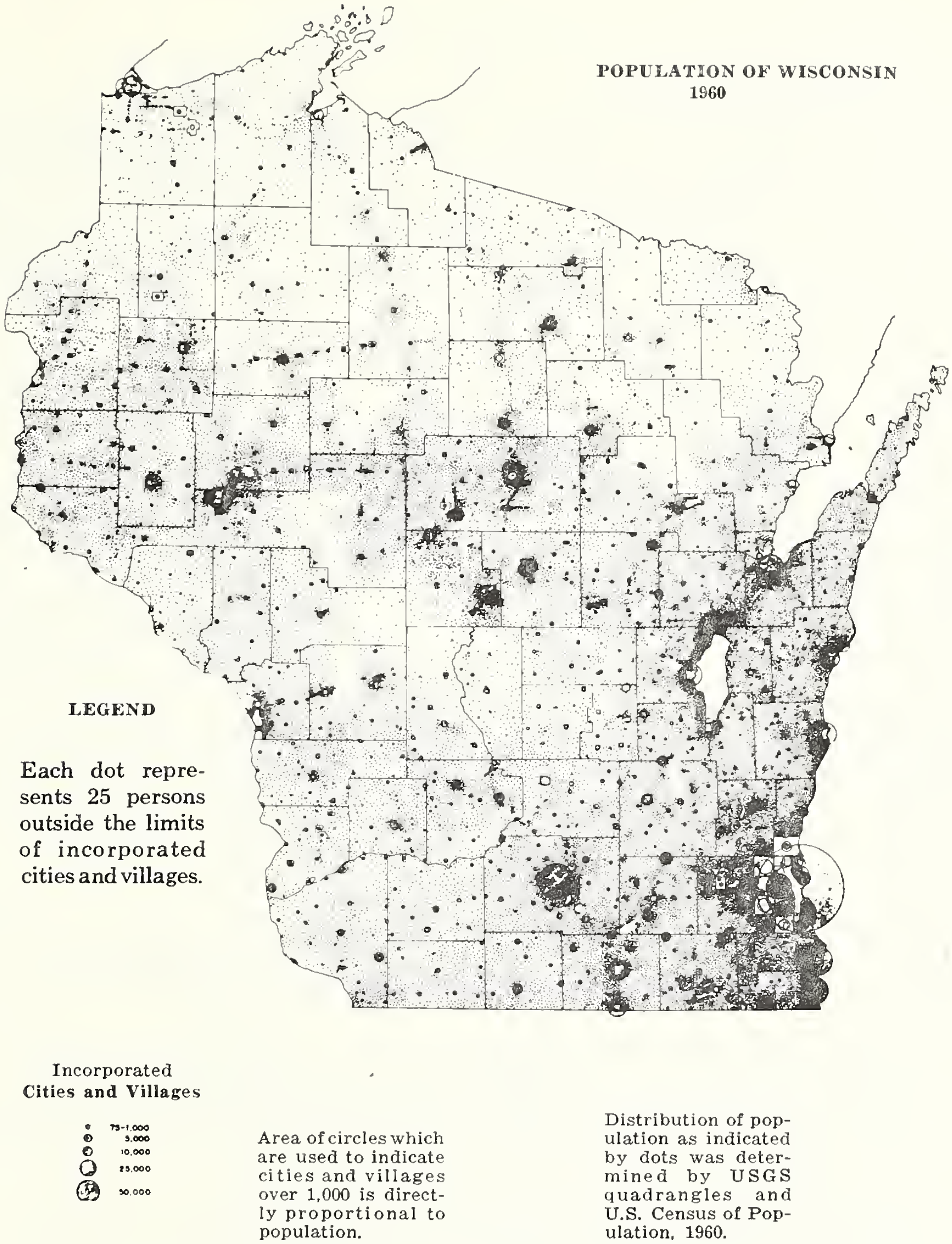


Figure 6. Population of Wisconsin, 1960. From Wisconsin Blue Book, 1964.

EARTH RESOURCES

Critical situations in farm animal waste management don't depend solely upon the present numbers and distribution of animals and people. These situations also relate to properties of our earth resources which influence the partitioning of our precipitation between groundwater and surface runoff, the rapidity of water movement in and over the land, the detention of water in ponds, lakes and flowages, the recharge of wells, and the use of the land for various kinds of livestock farming or for urban development.

Geology

If the surficial material were removed from the state, the underlying bedrock would be as shown on the "Geologic Map of Wisconsin" in Figure 7. As can be seen, the bedrock geology in the state is distinctly different between regions. In northern Wisconsin, granite and undifferentiated igneous and metamorphic formations form the bedrock; in central and west central regions, sandstone predominates; the eastern region is underlain by dolomitic limestone formations; and the bedrock in the southwestern region is chiefly dolomite with some shales and sandstones.

Land forms vary considerably within the state from rugged bluffs such as those along the Mississippi, to irregular morainic landscapes with poorly developed surface drainage systems, to large level marshes such as the Buena Vista marsh.

Soils

The major associations of Wisconsin soils are shown on the Soils of Wisconsin leaflet map which is included as Figure 8.

There is a close correlation between soils and livestock distribution. Dairy cattle and calves are concentrated in associations I, B, Bp and the western portions of association F. Hogs, dairy cattle and other livestock are abundant in associations A, Ap and the western portions of D.

Soil associations develop in part in relation to factors of topography and surface drainage which are also related to runoff of animal manure from land. In associations A and D the landscapes are often rolling to hilly and steep. The network of surface drainage is well developed. Water may leave a field in the upper part of a watershed and flow rapidly from a rill to a natural waterway to a creek to a river. Depressions, marshes and ponds are scarce. Numerous soils are shallow over dolomitic limestone bedrock.

In associations B, Bp, F and I, the landscape has been molded by glacial processes. Relief is lower and surface drainage is often not well integrated. Undrained depressions, marshes, ponds and lakes are abundant. Runoff from upper portions of a watershed may pass through one or more areas of transitory storage before entering a permanent stream.

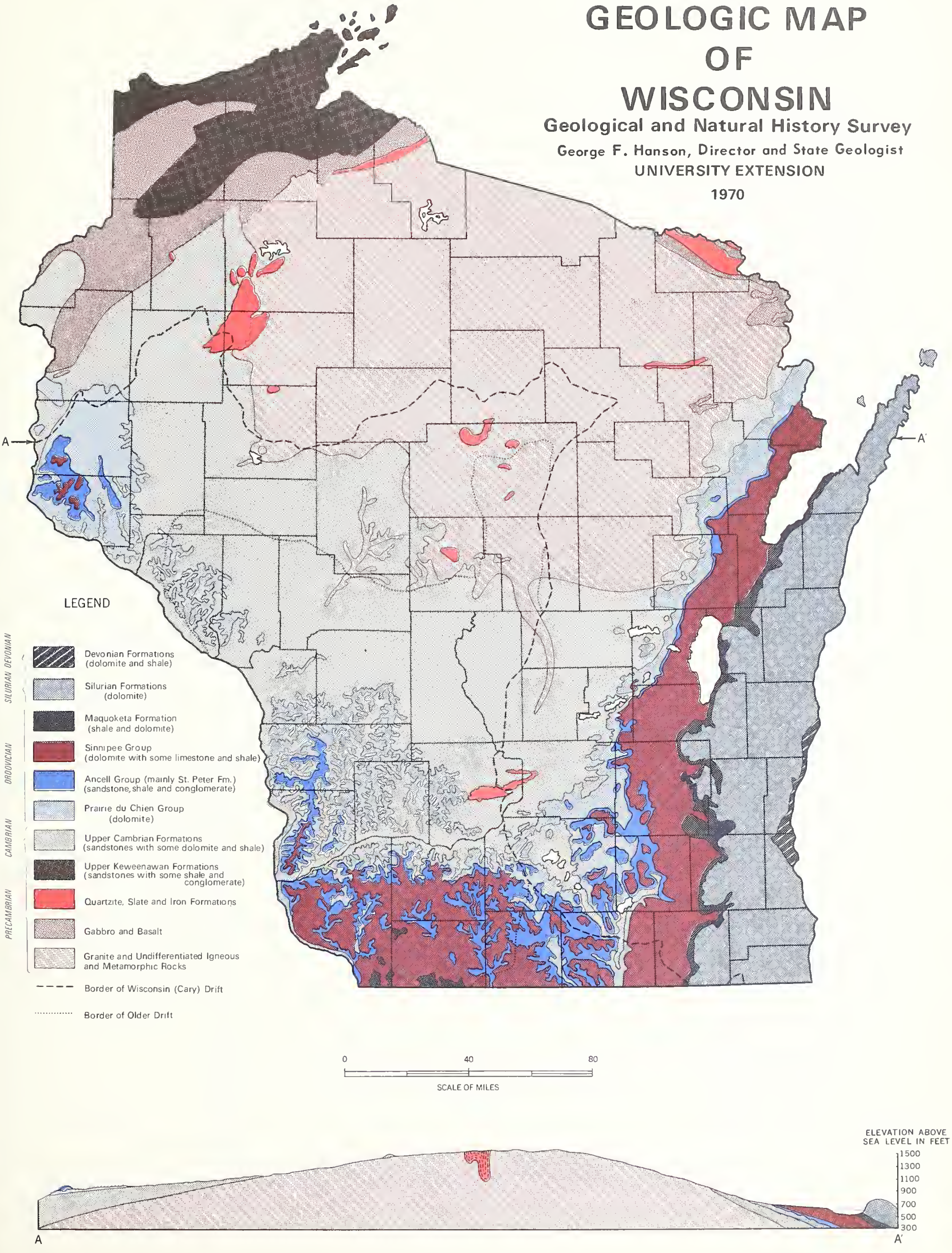
GEOLOGIC MAP OF WISCONSIN

Geological and Natural History Survey

George F. Hanson, Director and State Geologist

UNIVERSITY EXTENSION

1970



SHORT GEOLOGIC HISTORY OF WISCONSIN

The bedrock of Wisconsin is separated into two major divisions: (1) older, predominantly crystalline rocks of the Precambrian Era, which were extensively deformed after their deposition by movements of the Earth's crust; and (2) younger flat-lying sedimentary rocks of the Paleozoic.

The Precambrian Era lasted from the time the earth cooled, over 4,000 million years ago, until the Paleozoic Era which began about 500 million years ago. During this vast period of 3,500 million years sediments, some of which were rich in iron and which now form our iron ores, were deposited in ancient oceans, volcanoes spewed forth ash and lava, mountains were built and destroyed, and the rocks of the upper crust were invaded by molten rocks of deep-seated origin. Only a fragmentary record of these events remains but, as tree stumps attest the former presence of forests, the rocky roots tell the geologist of the former presence of mountains.

At the close of the Precambrian Era most of Wisconsin had been eroded to a rather flat plain upon which stood hills of more resistant rocks as those now exposed in the Baraboo bluffs. There were still outpourings of basaltic lava in the north and a trough formed in the vicinity of Lake Superior in which great thicknesses of sandstone were deposited.

The Paleozoic Era began with the Cambrian Period, the rocks of which indicate that Wisconsin was twice submerged beneath the sea. Rivers draining the land carried sediments which were deposited in the sea to form sandstones and shales. Animals and plants living in the sea deposited calcium carbonate and built reefs to form rocks which are now dolomite—a magnesium-rich limestone. These same processes continued into the Ordovician Period during which, as indicated by the rocks, Wisconsin was submerged three more times. Deposits built up in the sea when the land was submerged were partially or completely eroded at times when they were subsequently elevated above sea level. During the close of the Ordovician Period, and in the succeeding Silurian and Devonian periods, Wisconsin is believed to have remained submerged.

There are no rocks outcropping in Wisconsin that are younger than Devonian. Absence of this part of the rock record makes interpretation of post-Devonian geologic history in Wisconsin a matter of conjecture. Available evidence from neighboring areas, where younger rocks are present, indicates that towards the close of the Paleozoic Era, perhaps some 250 million years ago, a period of gentle uplift began which has continued to the present. During this time the land surface was carved by rain, wind and running water.

The final scene took place during the last million years when glaciers invaded Wisconsin from the north and sculptured the land surface. They smoothed the hill tops, filled the valleys and left a deposit of glacial debris over all except the southwest quarter of the State where we may now still see the land as it might have looked a million years ago.

Prepared by U. of W. Geological and Natural History Survey, 1963.

SOILS OF WISCONSIN

F. D. Hole, M. T. Beatty, and G. B. Lee

Published by The University of Wisconsin, Wisconsin Geological and Natural History Survey, Soil Survey Division.

Wisconsin's 350 soils can be grouped into ten general regions, with four additional subregions of predominantly prairie soils. As you travel across the state the regions appear as distinctly different landscapes. Differences in land form and land use between regions are related to characteristics of the soils.

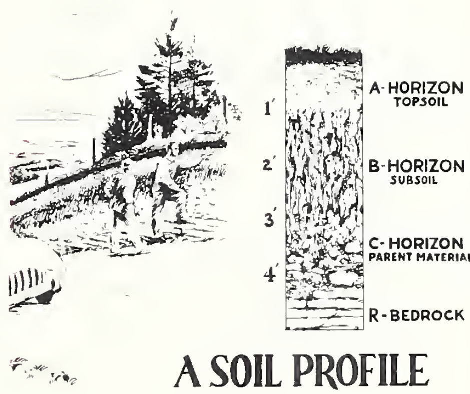


Figure 1.

In many bare road cuts we see soils exposed to a depth of several feet. Such exposures (Fig. 1) reveal the vertical cross-sections or "profiles" of soils comprised of horizons (layers) of topsoil, subsoil and underlying materials. Figure 2 gives profile sketches of some typical soils of the state.

Soils are named after geographic features, such as towns and streams. Waupun silt loam, for instance, was first described near Waupun, Wisconsin. Soil names may change from time to time as soil scientists learn more about the soils. The legend of this map identifies each soil region by the names of several major soils. Many other soils are present.

In cooperation with the Department of Soil Science, College of Agriculture, Madison, and the U. S. Soil Conservation Service.

1966

Fig. 8. Soils of Wisconsin, a generalized map.

In the level parts of sandy soil associations, C and Cp, much of the precipitation infiltrates the coarse textured soils and subsequently emerges in the streams as base flow.

Hydrology

Corresponding to the bedrock variation as well as other factors it can be seen on the map, "Ground-Water Provinces in Wisconsin" (Figure 9), that the aquifer characteristics follow a similar pattern. In the northern Drift Province, the underlying crystalline rock is impervious, although plentiful groundwater supplies are found in the sand and gravel surficial deposits of glacial origin. Throughout the Bedrock Province or Driftless Area, the mantle material overlying the sandstone, shale, limestones is generally thin and, therefore, is not an important source of water. However, the bedrock formations form adequate aquifers for shallow, low capacity wells.

Because Wisconsin is a "head water" state, its only source of water originates from precipitation, and the surface water that flows across the state boundary is discharged into neighboring states or boundary waters. As can be seen in Figure 9, the average precipitation pattern across the state varies slightly from extremes of 26 to 34 inches per year for a statewide annual average of about 31 inches. Although the total rainfall is sizeable, about two-thirds of this amount, or 20 inches, is recycled to the atmosphere by the transpiration of crops, vegetation and forest stands, and evaporation from surface water and moist soils. As a result, about 10 inches of water appears as runoff from much of the state. Because of the variations of bedrock, surface materials, vegetational cover, and land forms, the average annual runoff in rivers and streams ranges from 6 to 20 inches, generally increasing from south to north as shown by Figure 10.

Recent investigations have indicated that the flow of nutrient-rich water from natural or cultivated areas is experienced principally in relatively brief periods during the spring runoff. In the case of natural drainage, high levels of nutrients are discharged by marshes during the spring runoff because of the inactivity of the marsh vegetation and the possibility of leaching conditions during the winter periods.

Complementing the vast river systems, the state is rich in lakes. Wisconsin has over 4300 named inlakes and an equivalent number of unnamed lakes, which together cover approximately 6.5 million acres of the state. Figure 11 shows the distribution of named lakes according to county. According to the classification of size, there are 115 named lakes over 1000 acres, 1019 between 100 and 1000 acres, and 2104 named lakes with acreage less than 100. The quality of the lake water varies greatly between and within regions. Eutrophication (excess enrichment) has been identified as the most threatening problem to these resources.

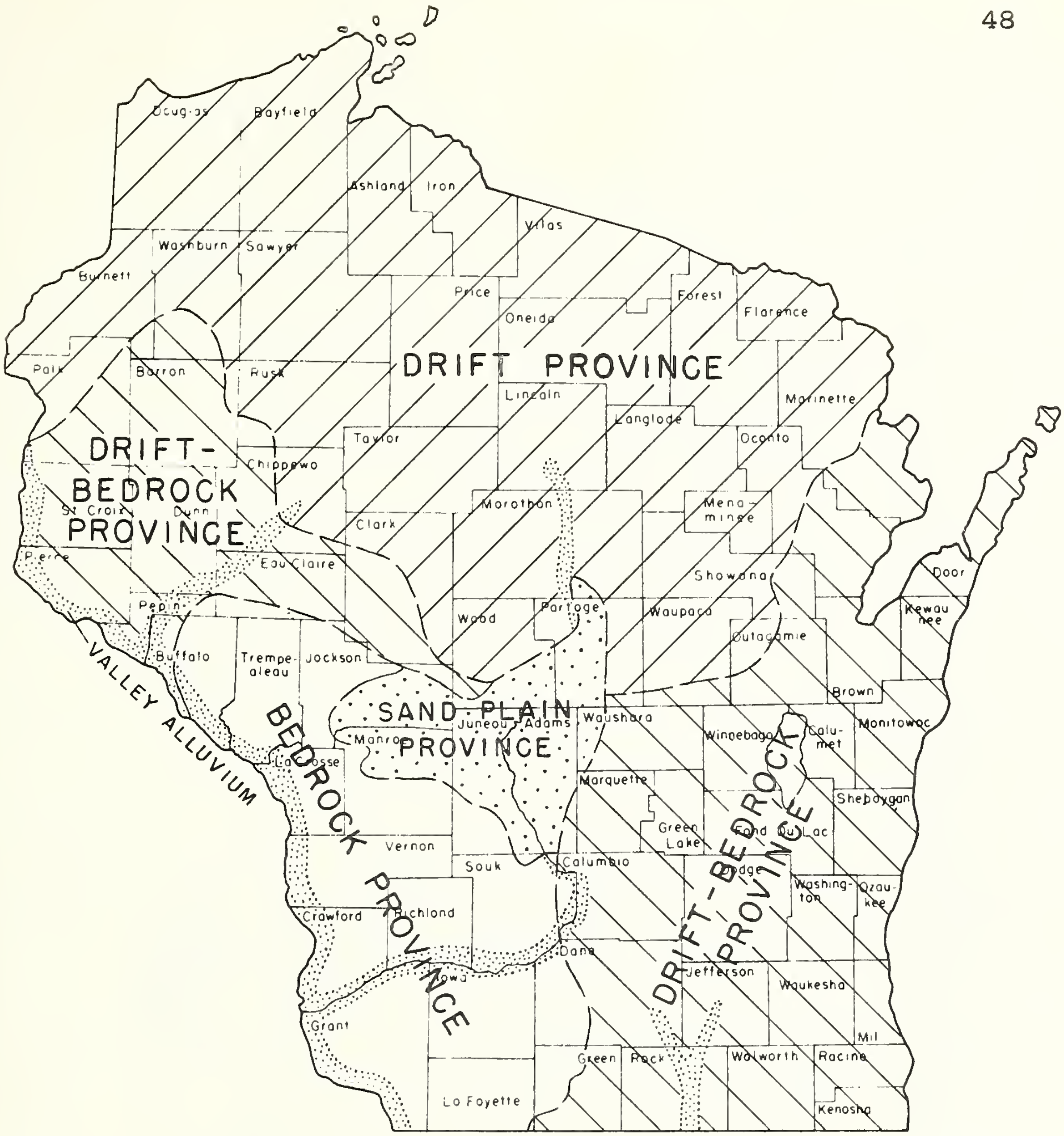


Figure 9. Hydrologic provinces of Wisconsin. From Wis. Blue Book, 1964.

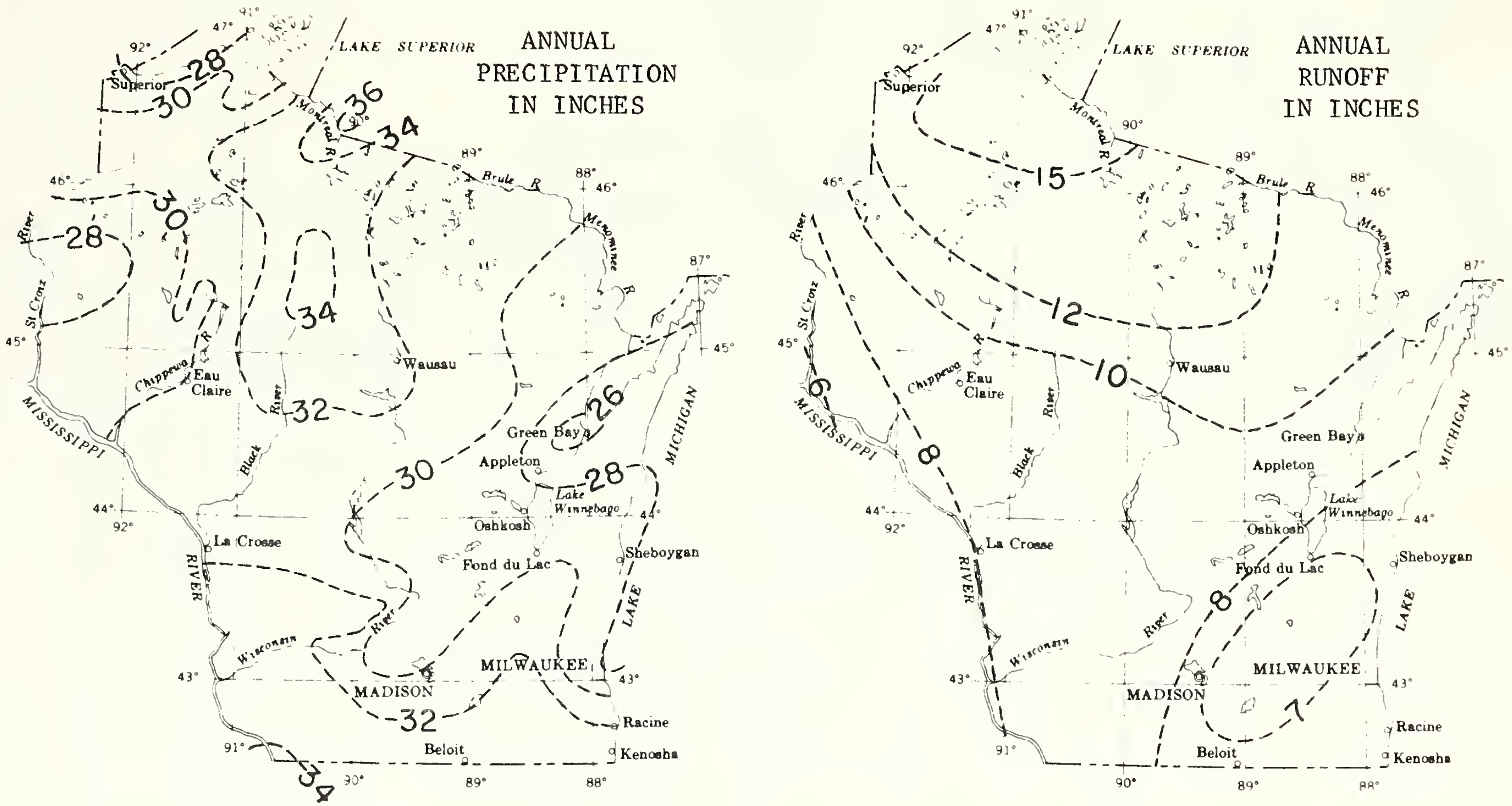
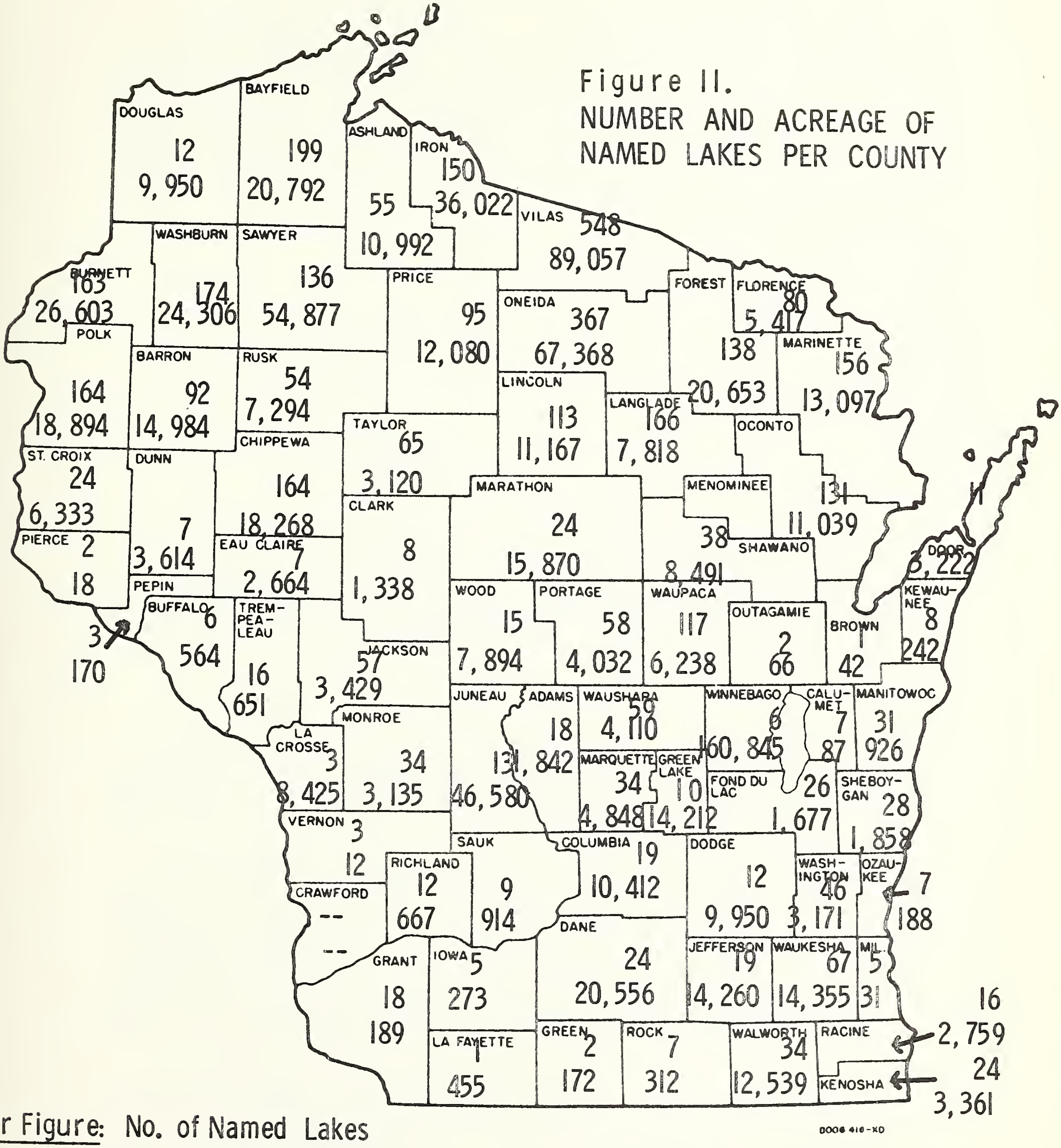


Figure 10. Maps of Wisconsin showing mean annual precipitation, 1931-60, and mean annual runoff. (Precipitation map compiled by H. E. Rosendahl, Wisconsin State Climatologist, 1967).

Figure II.
NUMBER AND ACREAGE OF
NAMED LAKES PER COUNTY



Upper Figure: No. of Named Lakes

Lower Figure: Acreage of Lakes in County

Ref. Wisconsin Lakes
Wis. Conservation Dept.,
Pub. 218-64

STANDARDS

In response to the enactment of federal and state legislation in 1965 and 1966, Wisconsin adopted water quality standards for the purpose of restoring and maintaining the interstate and intrastate waters as suitable for assigned uses. The predominant uses of Wisconsin water, in terms of areal extent, are for recreational use and for fish and other aquatic life. Although the long-range goal for the state is to permit the use of water for all lawful purposes, the following interim classifications are designated to selected reaches of rivers or lakes:

Minimum standards

1. For public water supply

2. For fish and other aquatic life
   a. Reproduction areas
   b. Fishing areas

3. For recreational use
   a. Whole body contact
   b. Partial body contact

4. For industrial and cooling water use

In review, the intermingling of the cultural developments with the state's natural resources forms our environment. Some of the elements of the natural system cannot be controlled and therefore it is necessary to manage those natural or cultural elements which can be varied.

CRITICAL SITUATIONS

Table 2 was developed to put into perspective some of the problems associated with farm animal waste management. It identifies the major variables in the system, elements of potential problems and a list of some of the major problems that could develop in critical situations.

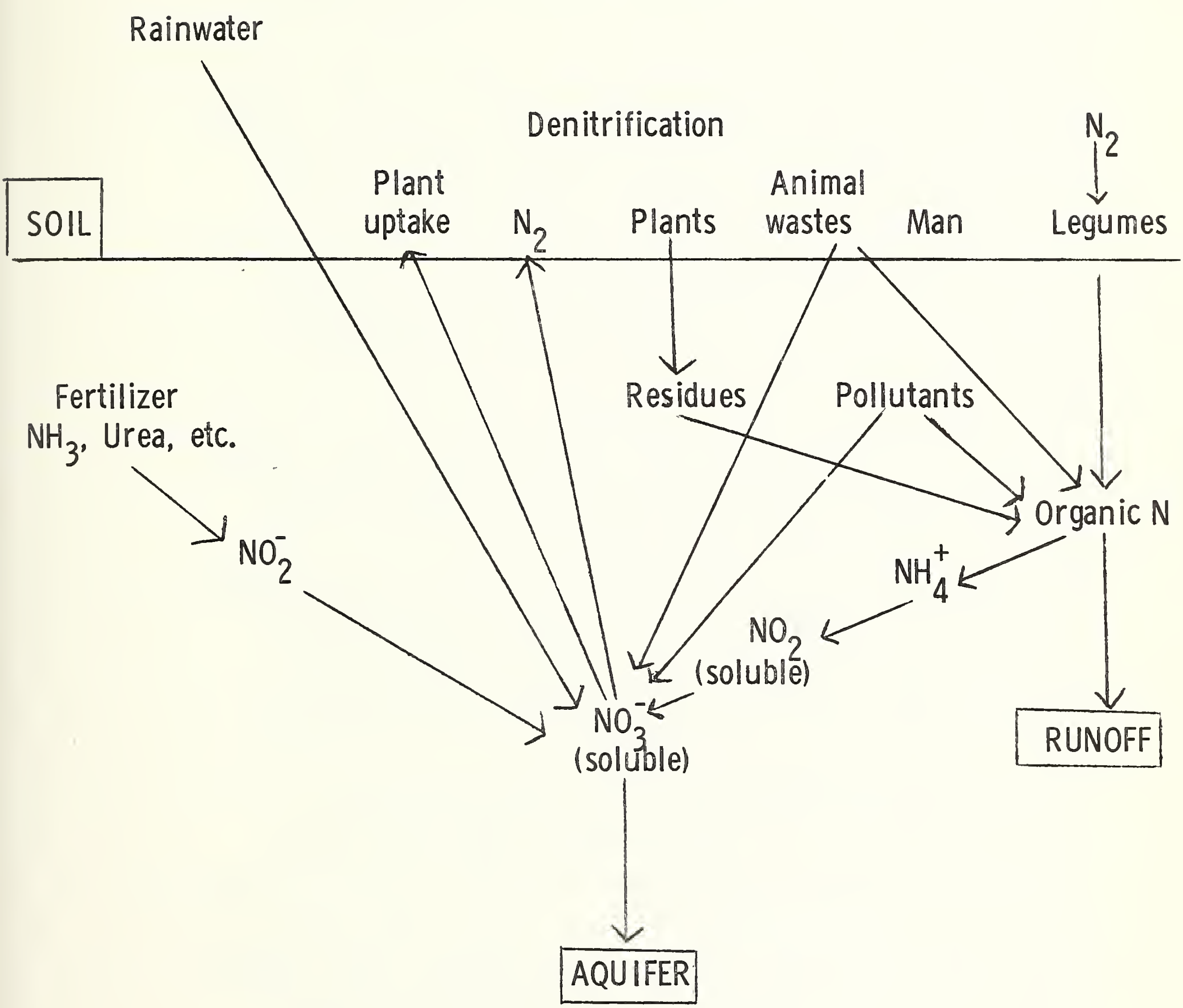
In considering problem situations, keep in mind that constituents of animal wastes which enter the soil or move with the surface water as runoff become part of an extremely complex cycle. Figure 12 shows that nitrogenous components may be immobilized or undergo a series of transformations before they have an effect upon waters. They are also far from being the sole contributors to the enrichment of our waters, so modifications in handling animal waste such as manure may or may not have a significant effect upon the quality of our waters.

Nevertheless there are a number of particularly critical situations that can be identified. Some occur locally, others may be widespread throughout a region. These are listed below. This list of problem situations is introductory. It is designed to stimulate your thinking and motivate your consideration of what problem situations exist in the geographic area in which you work. Perhaps it can serve as a preliminary check list for a problem survey.

Table 2. Major Variables, Elements of Potential Problems and Types of Problems Related to Farm Animal Wastes.

Major Variables	Elements of the Potential Problems	Problems
Population Density		
Farm Animal Density	Air	Odors
Geology		
Soil	Animal Waste	Offensive Sights
Land Forms	Land	Loss of Nutrients from Soil
Surface Runoff		
Groundwater	Surface Water	Excessive Enrichment of Surface Waters, Especially Lakes
Land Use	Groundwater	Buildup of Nitrate Concentration in Groundwater
Wind	People	Organic Pollution of Surface Waters

Figure 12. NITROGEN REACTIONS IN SOILS



1. Livestock concentrations near urban residential areas or rural non-farm residences.

   Problems: Odors, dust, flies, noise

   Locations: Wherever people and animals are in close proximity. Statewide, the southeastern and south central areas have the highest probability of problems. Proliferation of strip developments of rural non-farm residences makes the problem possible nearly anywhere.

2. Extremely large livestock concentrations.

   Problems: Volumes of wastes and by-products such as odors, dust, etc. are so great as to require careful consideration of locations, disposal of wastes, etc. Evidence of local groundwater contamination near large animal concentrations is widespread.

   Locations: Most existing large concentrations consist of broilers or laying hens. If large beef or hog feedlots like those in Iowa and Kansas develop here, the attendant problems will develop. If development is close to people (see No. 1 above) the problem is compounded.

3. Livestock in watersheds with lakes or impoundments.

   Problems: High livestock densities and productive farming lead to generally "rich" waters. Winter runoff from manured land may enrich the lakes or flowage. This enhances eutrophication. In general livestock densities are greatest in productive watersheds.

   Locations: The south central and northeastern parts of Wisconsin consist largely of watersheds with this combination of characteristics. Glacial lakes are numerous. Farms are productive and livestock numbers are high. The situation may vary locally within the area as to intensity of farming, the hydrology of the watersheds, the conditions of lakes, and the kinds of demands being placed upon the surface water resources.

   In western Wisconsin this problem will become more serious as additional multiple purpose impoundments are constructed through the PL 566 or other programs.

4. Watersheds without lakes or impoundments which contain large numbers of livestock along stream channels and floodplains.

   Problems: Many farmsteads were originally established near a stream. Barnyards often adjoin or cross the stream channel of a floodplain. As farm animal numbers grow and as animals are confined year-around, the manure produced in these yards increases as well. If it is washed into streams, it may reduce available oxygen to or below critical levels, discolor the water, impart odors, etc.

Locations: The problem is probably widespread, especially in western Wisconsin where valleys are long and narrow.

5. Livestock concentrations on shallow soils over previous bedrock.

Problem: Groundwater contamination.

Locations: As pointed out in Figure 7, Wisconsin contains large areas of dolomitic limestone bedrock. In areas such as the Door Peninsula, Longrie and Summerville, soils which are less than 36 inches thick over limestone dominate the landscape, and groundwater contamination hazards are great. In southwestern Wisconsin where shallow soils such as Dubuque, Edmund, Dunbarton and Sogn are extensive, the hazards of groundwater contamination are likewise great. A similar situation can also develop where soils are thin over cracked and porous granite, which serves as an aquifer. In areas such as these, detailed site evaluations may be needed if large livestock concentrations are to be developed.

6. Large livestock concentrations on extremely sandy soils.

Problem: Groundwater contamination.

Locations: Central Wisconsin contains extensive areas of nearly level, highly permeable sandy soils such as Plainfield, Kellner and Onamia. Nitrates and ammonium-N from feedlots on these soils can be expected to infiltrate the soil since surface runoff is usually negligible. Table 3 shows the buildup of these nitrogen compounds at Hancock, Wisconsin, with virgin jackpine shown for reference.

Table 3. Effect of Land Use on Nitrate and Ammonium in Soil Profiles.

	Lb./A to 20 ft.	
Land Use	Nitrate-N	Ammonium-N
	Hancock, Wisconsin	
Virgin soil -- Jack pine	56	21
Cultivated	142	31
Barnyard	407	2,203

Adapted from data of Olsen, Ph.D. Thesis, University of Wisconsin, 1969.

7. Animal manure spread on sloping land in winter.

Problem: Spreading fresh manure on snowy frozen fields creates a risk of substantial losses in the event of a winter rain or a rapid thaw of the snow. Manure contains considerable nitrogen and some phosphorus in water soluble forms and these constituents can move with the runoff. Table 4 shows the widely variable losses which have been measured in the limited studies conducted to date.

Table 4. Some Reported Losses of N and P from Manure Spread on Frozen Ground.

	Lb./A Loss in Runoff	
Situation	N	P
Fresh manure (15 T/A) spread on frozen 11% slope in winter; 3/4" rain next day. Data of Hensler, et al., Wisconsin, 1967.	21	4
Fresh manure (15 T/A) spread on frozen 11% slope in winter. Data of Hensler, et al., Wisconsin, 1968.	0	0
Fresh manure (10 T/A) spread on snow on 8% slope in winter. Data of Midgley and Dunklee, Vermont.	3	1

The magnitude of losses in two of the three years are great enough to indicate that this practice has the potential, given the right combination of circumstances, of contributing a substantial portion of the total nitrogen and phosphorus which have been reported to run off agricultural lands. This is particularly the case with phosphorus as all other reported losses in surface runoff or groundwater are well below 1 lb./acre per year.

Locations: Losses from manure spread in the winter will be greatest in those areas where slopes are long and steep and the surface drainage network well developed (as in western Wisconsin). The potential damage of the nutrients lost in the runoff will probably be greatest in those watersheds where water is impounded in lakes or reservoirs.

CONCLUSIONS

After reviewing the existing and potential critical situation in the state, the following conclusions were reached:

1. In the eastern and southern regions of the state, there is a significant interaction between people and farm animals. These interactions may occur locally elsewhere, as well.

2. Soil, geologic materials and land forms vary between regions and within sub-regions. These differences will require careful consideration in waste management practices.

3. Hydrologic variations are significant and must be considered on a local, regional or watershed basis.

4. Groundwater aquifers are being affected by current farm animal waste and land use practices in several areas of the state. Because of the hazard that can result from high levels of nitrate concentration to humans and livestock, nitrogen materials, such as manure, must be well managed.

5. A single solution for solving the problems of farm animal wastes does not exist. A diversified approach is imperative.

HOMEWORK QUESTIONS

What are the specific concentrations of animal waste in your area?

Where in your area does there exist or potentially exist a significant interaction between animal waste and people?

What are the surface water quality standards in your area? Are these standards being met? Do current animal waste handling practices adversely affect streams by organic pollution or lakes by nutrient enrichment?

Have well waters in your area been checked to determine if high nitrate concentrations are being created? If so, what are the sources?

In summary,

Have you investigated areas where critical situations could exist?

Are problems present or will they potentially develop?

What are the causes of the problems?

What changes can be instituted to correct the critical situations?

In closing, we would like to suggest the philosophical point that we should all concentrate on developing a high quality environment and avoid developing management or control practices which only permit us to avoid critical conditions.

CONSIDERATIONS IN SELECTING DAIRY MANURE DISPOSAL SYSTEMS

O.I. Berge, E.G. Bruns, T.J. Brevik, L.A. Brooks*

METHODS OF HANDLING MANURE

Daily Hauling

- The labor of hauling is distributed throughout the year, but manure hauling is a daily problem and the operator needs to be out in all kinds of weather often at great discomfort.
- There is no accumulation as with stacking or liquid.
- Odor problem is minimized.
- Investment in facilities is less than with stacking or liquid.
- Fields may not always be available for spreading because of crop cover or bad weather.
- Runoff may be excessive on some fields, particularly on frozen ground, which will result in loss of fertilizer value.
- Using the tractor and equipment in cold weather increases wear.
- Special attention should be given to saving the urine portion by using liquid tight spreaders.

Stacking

- Investment is less than with liquid for long term storage.
- Storage may be used during periods when fields are not available for or do not permit daily spreading.
- An additional tractor with manure loader is needed besides spreading equipment.
- Stack detracts from the appearance of the farmstead if it is poorly located, but it should be convenient for loading and hauling.
- Cattle must be kept away from the stack.
- Labor requirements may interfere with spring planting.

* Extension Agricultural Engineers, Agricultural Engineering Department
University of Wisconsin, Madison

- A dairy plant fieldman should be consulted regarding the acceptability of stacking in the summer.

- Plenty of bedding should be used to minimize runoff from the stack or an auxiliary liquid tank for urine only can be used.

- Nitrogen losses can be minimized by discing or plowing under shortly after spreading.

Liquid

- Year round storage is possible with adequate storage tank capacity.

- Maximum amount of manure can be saved if worked into the soil shortly after spreading.

- Milkhouse and parlor waste can go into manure storage tank, but human waste cannot.

- Investment in storage tank and equipment is high.

- Additional equipment is required for agitating, pumping and hauling.

- Odors can be a problem especially when spreading.

- Labor requirements for hauling may interfere with spring planting.

- Bedding must be minimized and foreign material kept from entering storage tank.

- Yard manure may have to be stacked during freezing weather because frozen manure, ice or snow should not be put into the storage tank.

- All openings into the tank must be guarded to protect animals and people.

- Location and construction of the tank should allow year around access and prevent freezing.

- Tank size and access opening should be planned for ease of agitation and removal.

The following tables are presented as guidelines for comparing the principal cost factors for manure handling alternatives. Similar tables may be constructed for other herd sizes by substituting appropriate cost factors.

The liquid manure tank cost is based on contractor labor rather than home construction. The size allows for 150 days usable storage with an

allowance of one foot of liquid to remain in the tank and one foot of air space above. A 150-day storage period is considered essential under Wisconsin conditions to avoid the need to spread liquid manure when the fields are snow covered or too wet to support heavy spreading equipment. This makes the cost of the liquid manure systems high. The value of the extra manure saved and the relative convenience considerations would need to offset this difference in cost.

COMPARATIVE ANALYSIS OF MANURE HANDLING ALTERNATIVES

Table 1. Daily Hauling (50 Cow Stanchion Barn)

ITEM	INVESTMENT	DIRI[1] FACTOR	HOURS	HOURLY RATE	ANNUAL COST
Barn Cleaner	$2,000	.15	---	----	$ 300.00
Manure Spreader	1,200	.20 [2]	---	----	240.00
Use of Tractor [9]	---	---	365	$2.50	980.00
Labor (Daily)	---	---	365	1.50	545.00
TOTAL					$2,065.00

Table 2. Stacking Manure (50 Cow Stanchion Barn)

ITEM	INVESTMENT	DIRI[1] FACTOR	HOURS	HOURLY RATE	ANNUAL COST
Barn Cleaner	$2,000	.15	---	----	$ 300.00
Stacker	1,000	.15	---	----	150.00
Manure Platform	500	.10	---	----	50.00
Spreader	1,200	.15	---	----	180.00
Manure Loader	700	.15	---	----	105.00
Use of Tractor Loading	---	---	60	$2.70	162.00
Use of Tractor Hauling	---	---	60	2.50	150.00
Labor - Two Men Hauling	---	---	120	2.00 [5]	240.00
- Daily Hand Labor	---	---	120	1.50	180.00
TOTAL	$5,400				$1,517.00

Table 3. Liquid Manure Tank (50 Cow Stanchion Barn)

ITEM	INVESTMENT	DIRI[1] FACTOR	HOURS	HOURLY RATE	ANNUAL COST
Barn Cleaner	$ 2,000	.15	---	----	$ 300.00
Storage Tank (4)	9,000	.10	---	----	900.00
Hauling Tank Wagon	1,500	.15	---	----	225.00
Pump	2,000	.20	---	----	400.00
Use of Tractor Hauling	---	---	60	$2.70 (3)	162.00
Use of Tractor Pumping	---	---	80 (6)	2.50	200.00
Labor	---	---	70 (6)	2.00 (5)	140.00
TOTAL	$14,500				$2,327.00

Table 4. Stacking Manure with 50 Cow Free Stall Housing

ITEM	INVESTMENT	DIRI[1] FACTOR	HOURS	HOURLY RATE	ANNUAL COST
Tractor & Scraper (10 HP)	$ 1,000	.15	---	----	$ 150.00
Stacker	1,000	.15	---	----	150.00
Manure Platform	500	.10	---	----	50.00
Spreader	1,200	.15	---	----	180.00
Manure Loader	700	.15	---	----	105.00
Use of Tractor Loading	---	---	60	$2.70	162.00
Use of Tractor Hauling	---	---	60	2.50	150.00
Labor - Two Men	---	---	120	2.00 (5)	240.00
Daily Labor Scraping	---	---	180	1.50	270.00
TOTAL	$ 4,400				$1,457.00

Table 5. Liquid Manure with 50 Cow Free Stall Housing (Scraper Used)

ITEM	INVESTMENT	DIRI[1] FACTOR	HOURS	HOURLY RATE	ANNUAL COST
Storage Tank (4)	$ 9,000	.10	---	----	$ 900.00
Tractor and Scraper	1,000	.15	---	----	150.00
Spreader	1,500	.15	---	----	225.00
Pump	2,000	.20	---	----	400.00
Daily Labor	---	---	180	$1.50	270.00
Hauling Labor	---	---	70	2.00 (5)	140.00
Use of Tractor Hauling	---	---	60	2.70 (3)	162.00
Use of Tractor Pumping	---	---	80 (6)	2.50	200.00
TOTAL	$13,500				$2,447.00

Table 6. Liquid Manure with Slatted Floor over Tank (50 Cow Free Stall)

ITEM	INVESTMENT	DIRI[1] FACTOR	HOURS	HOURLY RATE	ANNUAL COST
Slatted Floor	$ 3,000(7)	.10	---	----	$ 300.00
Storage Tank(4)	9,000	.10	---	----	900.00
Spreader	1,500	.15	---	----	225.00
Pump	2,000	.20	---	----	400.00
Hauling Labor	---	---	70	$2.00(5)	140.00
Use of Tractor Hauling	---	---	60	2.70	162.00
Use of Tractor Pumping	---	---	80(6)	2.50	200.00
Daily Labor	---	---	---	----	----
Ventilation(8)	---	---	---	----	100.00
TOTAL	$15,500				$2,427.00

Table 7. Summary Comparison of Investment and Annual Cost of Manure Handling Alternatives

ALTERNATIVE	INVESTMENT	ANNUAL COST
Daily Hauling (Stanchion)	$ 3,200	$ 2,065
Stacking (Stanchion)	5,400	1,517
Liquid Manure (Stanchion)	14,500	2,327
Stacking (Free Stall)	4,400	1,457
Liquid Manure (Free Stall)	13,500	2,447
Liquid Manure (Free Stall - Slatted Floor)	15,500	2,427

Table 8. Approximate Daily Manure Production

ANIMAL	CU. FT. PER DAY[10] SOLIDS & LIQUID	PERCENT WATER	GALLONS PER DAY
1000 lb. Cow	1 1/2	80-90	11
1000 lb. Steer	1	80-90	7 1/2
1000 lb. Horse	3/4	65	5 1/2
10 head of Hogs			
50 lb.	2/3	75	5
100 lb.	1 1/3	75	10
150 lb.	2 1/4	75	17
200 lb.	2 3/4	75	20 1/2
250 lb.	3 1/2	75	26
10 head of Sheep	1/2	70	4
1000 5-lb. Layers	3	55-75	22 1/2

FOOTNOTES FOR TABLES

[1] DIRI = Depreciation, Interest, Repairs, Insurance and Taxes where applicable.

[2] Manure spreaders used daily wear out faster.

[3] Larger tractor used for a 1500 gallon tank.

[4] Tank capacity for 150 days based on 50 cows, 2 cu. ft. per cow per day. 12 feet deep - 10 feet usable depth and $.50 per cu. ft.

[5] Labor cost increases slightly due to busy season competition.

[6] Includes agitation.

[7] Estimated increased cost due to shape of tank compared to tanks in previous examples. (Wall area about doubled and floor area about 30% more).

[8] Estimated increase in annual cost due to added ventilation needed.

[9] Includes time to start tractor, hitch to spreader, load, travel to and from fields, unloading, unhitching and parking tractor.

[10] There are about 34 cubic feet in a ton of manure.

VALUE OF DAIRY CATTLE MANURE

Replacement costs for the principal fertilizing elements per ton in dairy cattle manure are:

	Pounds in a ton		Price per pound		
Nitrogen	10 lb.	x	$ .07	=	$ .70
Phosphorus	2 lb.	x	.10	=	.20
Potassium	10 lb.	x	.05	=	.50
			Total/ton		$1.40

Other important values in manure are the minor elements that are present in very small quantities but are also needed in small amounts by crops.

The organic matter content of manure is beneficial to soil tilth. But there is probably little difference in organic matter loss with any of the handling methods, except through erosion or excessive heating in a stack in warm weather.

IMPORTANCE OF URINE

At least half of the nitrogen and two-thirds of the potassium are found in the urine, while phosphorus is mainly in the feces.

If half of the urine is lost by any of the handling systems, the cost to replace these elements would be:

Nitrogen in urine per ton of manure = 5 lb. x 1/2 = 2.5 lb. x $.07		= $.18
Potassium in urine per ton of manure = 6.6 lb. x 1/2 = 3.3 lb. x $.05		= $.16
Replacement value lost	Total/ton	$.34

In this example, 50 cows would produce about $\frac{50 \times 75 \times 365}{2000}$ = 685 tons of manure in a year and the replacement cost of the fertilizer lost in major elements in half of the urine would be 685 x $.34 = $233.00.

The loss of half the urine is possible, but it can be much less with any system properly operated. Thus the use of plenty of bedding and spreaders with liquid tight endgates will conserve the liquid from daily spreading. Tanks for the urine runoff may be used in conjunction with stacking. The liquid manure system will conserve all urine if tanks do not leak.

NOTE: All manure should be disced or worked in soon after spreading to minimize nitrogen loss. Tests at Wisconsin have shown up to 60% of nitrogen in fresh manure spread daily is lost within four days if manure is not worked into the soil at once.[1]

EQUIPMENT FOR MANURE HANDLING

Dependable equipment is always important, but it is especially so when handling manure. Repairing manure handling equipment is a most undesirable job, especially in severe winter conditions. The maintenance cost of this equipment is higher than many other types because of the conditions under which it operates.

New equipment developments for liquid manure handling have received the most attention in recent years, but there have also been useful equipment designs in other phases of manure handling. Many people have felt that all manure problems can be solved by handling it in liquid form. It is now evident that each farmer should analyze all manure disposal alternatives before deciding which method is most efficient, effective and economical for his particular livestock operation.

[1] From Henry & Morrison, Feeds and Feeding.

Most dairy farmers in Wisconsin have stall type barns and spread manure daily. Mechanical barn cleaners are practical for removing manure from a stall barn and have been improved through the years to provide generally good service. One of the major advantages of hauling and spreading manure daily is that the labor is distributed throughout the year. There is also a minimum investment in equipment and other facilities. A major disadvantage is the excessive runoff loss that may occur when spreading manure on snow and frozen ground. Fields may even be unavailable for spreading because of crop cover, wet fields or too deep snow. These and other disadvantages are causing farmers to consider storage facilities that will enable them to spread manure when weather and field conditions permit.

Manure stacking has not been a common practice in Wisconsin in recent years. But it is common during the winter in parts of the country where heavy snows are frequent. During the 1950's, several different types of stackers were used on the Electric Research Farm at Madison. Data taken from those stacking operations on time and labor requirements proved very favorable when compared to daily hauling. But the labor required for loading, hauling and spreading during April and May conflicts with the tillage and planting operations.

A tractor with a manure loader is needed in addition to the spreading equipment when hauling from the stack. But the wear and operational costs of the tractor and spreading equipment are much less than with daily hauling during freezing weather.

There are various types of manure stacking equipment in use. Some are merely an extension of the elevator section of an endless chain cleaner. One manufacturer has developed a swivel joint where the elevating section begins so the unit can be swung in an arc. The barn cleaner and stacker are actually one unit with only one chain and motor drive. A drop door is installed in the lower section of the elevator where a spreader can be driven under when manure is not being stacked. During freezing weather the cleaner should be stopped so that the section of chain in the elevator always remains outside. No serious maintenance problems during cold weather have been experienced when the unit has been properly operated.

There are other stackers on the market which are separate from the barn cleaner. One chain and slat elevator stacker has been available from a small Wisconsin manufacturer for over 15 years. It is a very satisfactory unit, but the number in use is relatively small because farmers are reluctant to change from the generally accepted practice of daily spreading. A more recent development by another Wisconsin barn equipment manufacturer is a throwing device for stacking manure.

It is most desirable to have the storage area paved and to have side walls to confine the manure. The bottom should be sloped so that any liquid remains in the storage area. With most stall barns there is sufficient bedding to absorb the urine, so drainage from the stack is not a problem. The stack should be located so that it does not detract from the appearance of the farmstead, but is still convenient for loading.

Most liquid manure handling systems on Wisconsin dairy farms are installed with freestall housing. Shape and size of the storage tank will vary with the method of agitation. To provide for 150 days storage capacity, it is usually necessary to construct more than one tank. Insufficient storage capacity is often a basic cause of many problems connected with liquid manure handling.

The combination pump and recirculation unit is most popular for unloading storage tanks in this area. With hog operations and other installations where agitation is not a serious problem, the vacuum loading spreader tank is often used. Liquid agitation, pumping and hauling equipment has gone through a rapid development stage and is continually being improved in quality of construction.

Storing the manure and then field spreading seems practical for the majority of Wisconsin farmers as they have sufficient land on which to dispose of it. Spreader tanks of about 1400 gal. capacity are the most commonly used. Pumping liquid manure through a sprinkler irrigation system is a worthwhile consideration if it is free of trash and bedding. The labor requirements are very low and the system may be operated when fields are too wet for using spreader tanks.

Odors when spreading are a very critical problem. Experimental work has been done on mounting a plow on a spreader tank to cover the manure as it is placed in the furrow bottom. At least one manufacturer now has a spreader tank on the market that is equipped with shovels to place the manure under the soil surface.

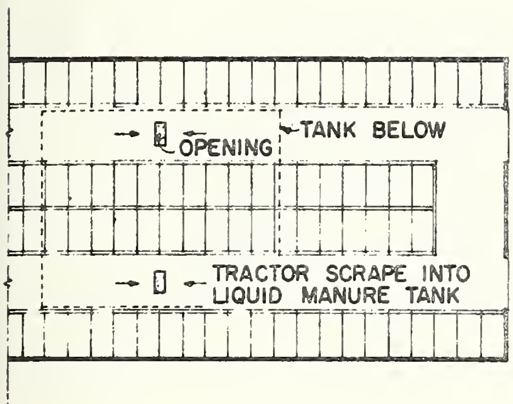
Oxidation ditches are being used successfully in some confined hog operations. Several companies are manufacturing paddle wheel units to keep the material moving and incorporate air into the liquid. The principle in this system is to supply enough oxygen to micro-organisms in the waste so they break down the solids. Foaming has been a problem under some conditions, and it appears essential to have the size of paddle wheel and ditch correctly designed in relation to the number of animals.

Experimental work is now in progress at several institutions on mechanical aeration of lagoons. Floating aerators have been successful, but other systems such as compressed air through perforated pipes may be used. Adding wastes at regular intervals several times daily maintains a balance between the oxygen requirements of the bacteria and the capacity of the aeration systems.

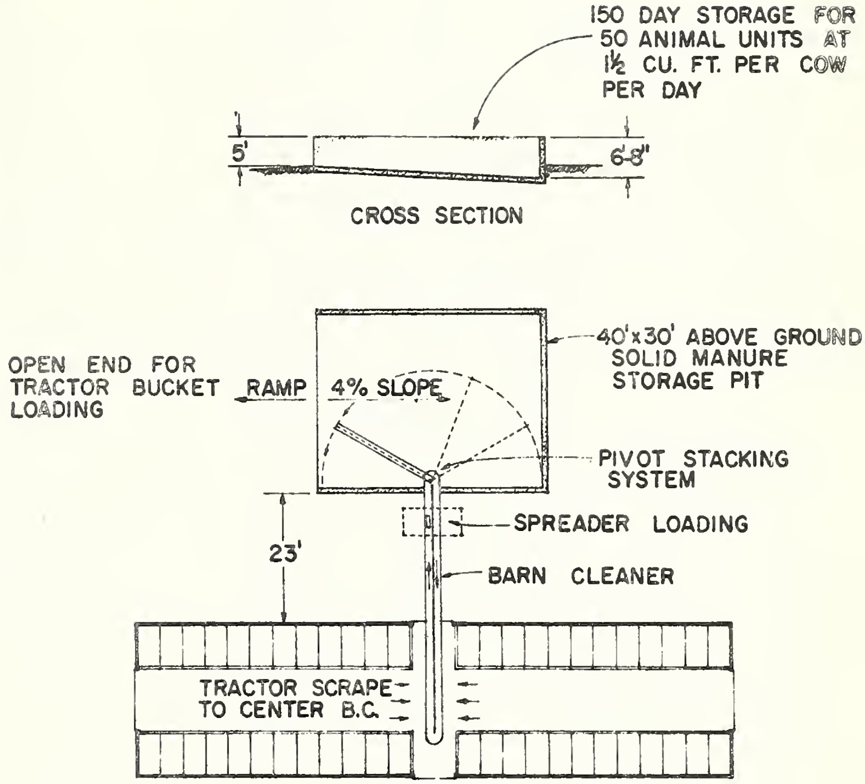
Drying of animal wastes has been done for years to obtain a product which is marketable as a lawn, garden and house plant fertilizer. Although drying costs may be higher than the value of the manure as a farm fertilizer, it could be a possible alternative for consideration in some areas. There have been problems with air pollution from some installations, but other drying operations are fairly odor-free.

The desirable manure handling system and equipment required varies with the type of livestock operation. Whether manure is handled as a liquid or solid, it appears that storage facilities are essential for an efficient system that will minimize fertilizer losses.

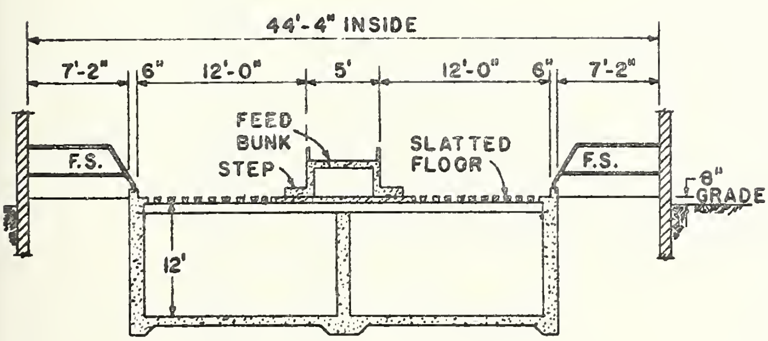
MANURE HANDLING METHODS FOR FREE STALL HOUSING



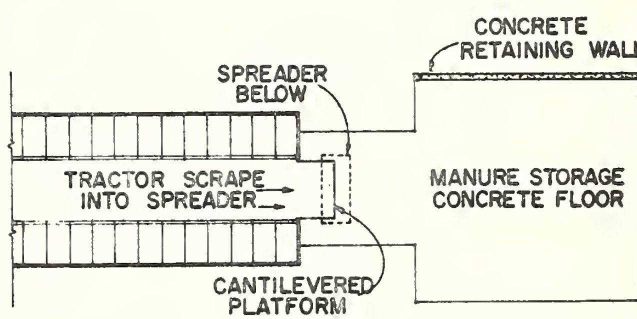
4 ROW FREE STALL
LIQUID MANURE STORAGE



2 ROW FREE STALL
DAILY HAULING AND/OR STORING SOLID MANURE



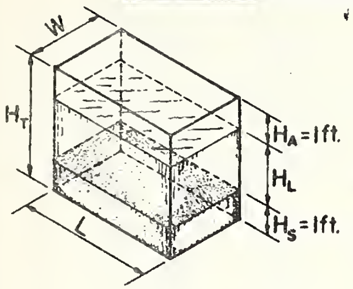
2 ROW FREE STALL FACILITY
WITH INSIDE FEEDING
SLATTED FLOOR
LIQUID MANURE STORAGE



2 ROW FREE STALL
DAILY HAULING AND/OR STORING SOLID MANURE

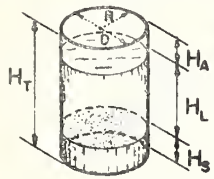
FORMULAS FOR DETERMINING VOLUMES OF STRUCTURES FOR LIQUID MANURE STORAGE

SQUARE OR RECTANGULAR STRUCTURE



W = INSIDE WIDTH IN FEET
L = INSIDE LENGTH IN FEET
H_T = TOTAL INSIDE HEIGHT OF TANK IN FEET
H_A = HEIGHT ALLOWED FOR AIR SPACE
H_L = LIQUID STORAGE DEPTH IN FEET
H_S = HEIGHT ALLOWED FOR LIQUID AND SOLID AT TANK BOTTOM
1 CUBIC FOOT = 7.5 GALLONS

STORAGE CAPACITY OR VOLUME (IN CUBIC FEET) = $W \times L \times H_L$
STORAGE CAPACITY OR VOLUME (IN GALLONS) = $W \times L \times H_L \times 7.5$



ROUND STRUCTURE

$V = \pi R^2 \times H_L$ OR $V = \frac{1}{4} \pi D^2 \times H_L$
R = RADIUS (INSIDE) = ½ D
D = DIAMETER (INSIDE) = 2R
$\pi = 3.1416$

STORAGE CAPACITY OR VOLUME (IN CUBIC FEET) = $3.1416 \times R^2 \times H_L$
STORAGE CAPACITY OR VOLUME (IN CUBIC FEET) = $\frac{1}{4} \times 3.1416 \times D^2 \times H_L$
STORAGE CAPACITY OR VOLUME (IN GALLONS) = $0.7854 \times D^2 \times H_L \times 7.5$

FOR TOTAL INSIDE HEIGHT OF TANK IN FEET = H_T

$H_T = H_A + H_L + H_S$ OR $H_T = 2$ FEET $+ H_L$

TABLE 2b - [1]LIQUID MANURE STORAGE REQUIREMENTS

TOTAL STORAGE REQUIREMENTS FOR VARIOUS NUMBER OF ANIMAL UNITS AND STORAGE PERIODS

TOTAL NO. ANIMAL UNITS	PER DAY		120 DAYS		150 DAYS		180 DAYS	
	CU. FT.	[2]GAL.	CU. FT.	[2]GAL.	CU. FT.	[2]GAL.	CU. FT.	[2]GAL.
100	200	1500	24000	180000	30000	225000	36000	270000
80	160	1200	19200	144000	24000	180000	28800	216000
70	140	1050	16800	126000	21000	157500	25200	189000
60	120	900	14400	108000	18000	135000	21600	162000
50	100	750	12000	90000	15000	112500	18000	135000
40	80	600	9600	72000	12000	90000	14400	108000
30	60	450	7200	54000	9000	67500	10800	81000

[1] BASED ON 2 CUBIC FEET PER COW AND / OR ANIMAL UNIT PER DAY (WHERE 1 COW AND / OR 2 HEIFERS = 1 ANIMAL UNIT)

[2] 1 CUBIC FOOT = 7.48 SAY 7.5 GALLONS

TABLE - 3

SIZE OF TANKS FOR VARIOUS STORAGE CAPACITIES AND DEPTHS FOR LIQUID MANURE STORAGE

STORAGE CAPACITY		SHAPE OF STORAGE STRUCTURE & LIQUID STORAGE DEPTH							
		LIQUID STORAGE DEPTH (H_L) = 10 FEET TOTAL TANK DEPTH INSIDE (H_T) = 12 FEET				LIQUID STORAGE DEPTH (H_L) = 12 FEET TOTAL TANK DEPTH INSIDE (H_T) = 14 FEET			
		SQUARE	RECTANGULAR		ROUND	SQUARE	RECTANGULAR		ROUND
CUBIC FEET	GALLONS	W = L	W = 10 FT. L (FEET)	W = 20 FT. L (FEET)	D = DIAMETER	W = L	W = 10 FT. L (FEET)	W = 20 FT. L (FEET)	D = DIAMETER
20000	150000	45'-0"	200	100	50'-6"	41'-0"	166'-6"	83'-6"	46'-0"
18000	135000	42'-6	180	90	48'-0"	38'-6"	150'-0"	75'-0"	44'-0"
16000	120000	40'-0"	160	80	45'-0"	36'-6"	133'-6"	66'-6"	41'-6"
14000	105000	37'-6"	140	70	42'-0"	34'-0"	116'-6"	58'-6"	38'-6"
12000	90000	34'-6"	120	60	39'-0"	31'-6"	100'-0"	50'-0"	35'-6"
10000	75000	31'-6"	100	50	36'-0"	29'-0"	83'-6"	41'-6"	32'-6"
8000	60000	28'-6"	80	40	32'-0"	26'-0"	66'-6"	33'-0"	29'-0"
6000	45000	24'-6"	60	30	27'-6"	22'-6"	50'-0"	25'-0"	25'-6"
4000	30000	20'-0"	40	20	22'-6"	18'-6"	33'-6"	16'-6"	20'-6"

ADDITIONAL PUBLICATIONS AND PLANS AVAILABLE

ON LIVESTOCK AND HUMAN WASTES

Available from your County Agricultural Extension Office or Agricultural Engineering Department, College of Agriculture, University of Wisconsin, 460 Henry Mall, Madison, Wisconsin 53706

LIVESTOCK WASTE

COST		
Free	Manure - Valuable By-Product of Dairying	Univ. of Wis. Cir. 550
Free	Liquid Manure Handling for Dairy Cattle - Recommended Guidelines	Univ. of Wis. Mimeo
*$1.00	Dairy Equipment Plans Book	Midwest Plan Service
*$1.00	Beef Equipment Plans Book	Midwest Plan Service
*$1.00	Swine Equipment Plans Book	Midwest Plan Service
*$1.00	Sheep Equipment Plans Book	Midwest Plan Service
*$1.00	Poultry Equipment Plans Book	Midwest Plan Service
Free	Handling Liquid Manure	MWPS Agr'l Engrs. Digest
Free	Lagoon Manure Disposal	MWPS Agr'l Engrs. Digest
Free	Concrete Liquid Manure Tanks	Portland Cement Ass'n.
Free	Concrete Manure Handling Improvements	Portland Cement Ass'n.

USDA PLANS FOR LIQUID MANURE STORAGE TANKS

**$ .75	Rectangular 6 to 10 feet deep 20 foot width- any length	Plan No. 5981
**$ .75	Circular 6 to 10 feet deep 32 or 48 foot diameter	Plan No. 5984
**$ .25	Rectangular 10 feet deep - 12 to 24 foot width - any length	Plan No. 5987

HUMAN WASTES

Free	A Safe Water Supply	State Board of Health and Univ. of Wis. Circular
Free	Concrete Structures for Farm Water Supply and Sewage Disposal	Portland Cement Ass'n.

* Make checks payable to: University Extension - Midwest Plans

** Make checks payable to: Wisconsin College of Agricultural and Life Sciences

ENGINEERING RESEARCH ON FARM ANIMAL MANURE

Clyde Barth*

Farm animal waste management is a significant problem for livestock farmers. It has intensified in recent years due to (1) the large volumes that must be handled, (2) the characteristics of the waste and (3) the influence of urban and rural non-farm residents.

Engineering research on disposal and utilization of farm animal manure has been extensive in the last five years. While agricultural engineers have been very active in this work, we recognize quickly the valuable contributions being made by others. The work of such disciplines as sanitary engineering, animal and poultry sciences, bacteriology, soil science, agronomy, and agricultural economics has been essential to the development of a broad program in this important field.

Research on farm animal manure has emphasized disposal. The questionable economics of using the plant nutrients for crop production have prompted the idea of getting rid of manure in the least expensive way. To make the job of handling manure less objectionable, it has been fluidized in the interest of mechanization. This liquified product has different characteristics than the raw material and offers problems of its own. Other problems, due to proximity and sensitivity of neighbors, have given cause for greater concern about the nuisance of odors and gases produced by manure.

CHARACTERIZATION

Knowledge of the properties of the raw material is essential. Extensive characterization of livestock wastes has been made. Wastes in the form of raw manure, raw manure with litter, stored manure, treated manure and feedlot runoff have been analyzed. Characterization included determinations of the amounts of manure produced. The work produced information such as that in the following tables.

* Extension Agricultural Engineer
University of Wisconsin, Madison

TABLE 1

Livestock Waste Characteristics

Item	Dairy Cattle	Beef Cattle	Poultry	Swine	Sheep
Animal size, lb.	1000	1000	5	100	100
Wet manure, lb./day	65	60	0.25	8	4
Manure density, lb./ft^3	62	60	60	62	65
Moisture, %	85	85	72	82	77

TABLE 2

Nutrients in Livestock Wastes
lb/ton Wet Manure

Animal	N	P	K	S	Ca	Fe	Mg
Dairy Cattle	11.2	2.0	10.0	1.0	5.6	.08	2.2
Beef Cattle	14.0	4.0	9.0	1.7	2.4	.08	2.0
Poultry	25.0	11.0	10.0	3.2	36.0	2.3	6.0
Swine	10.0	2.8	7.6	2.7	11.4	.56	1.6
Sheep	28.0	4.2	20.0	1.8	11.7	.32	3.7

BIOLOGICAL TREATMENT

With few exceptions the treatment of livestock wastes has been by biological means. Waste components are used by microorganisms and the waste volume is reduced. The products of complete aerobic biological degradation are water, carbon dioxide and a sludge made up of the microorganisms. The sludge and the water must then be disposed of in an appropriate manner. The process does not of itself provide ultimate disposal.

Anaerobic Lagoon

Several biological procedures are commonly used for waste treatment. The anaerobic lagoon was the first practice employed. The early units were constructed more by accident than by design and success was limited. But recent developments of the technique have led to satisfactory operating conditions.

The major value of the anaerobic system is its ability to efficiently break down organic matter. Another beneficial quality is the production of methane gas which can be a useful fuel, but efforts to collect and use methane have not been economical in the United States. The practice is also useful because:

- it reduces the solids volume needing disposal.
- a well-digested anaerobic sludge has little odor.
- it is a pretreatment procedure for other biological systems.

Several limitations of the anaerobic lagoon do exist; knowledge of these is essential in any design.

- Cold temperatures greatly reduce biological activity. During the winter in the upper Midwest, biological activity and the resulting rate of degradation is extremely low.
- Anaerobic lagooning results in about 50% reduction in the pollution potential. Effluent from such a lagoon is still highly pollutional.
- Solids must be removed from the lagoon or they will accumulate since they are only partially degraded. They must be removed (or a new lagoon constructed) before the function of the lagoon is impaired.
- Odor production must be anticipated. Odors may be produced when the lagoon is first put into operation, when it is emptied, after intermittent mixing or as temperatures rise in the spring.

Design information for the anaerobic lagoon is available. Functional units can be constructed, but they seem to be most beneficial when used in combination with other practices. The main purpose of the anaerobic lagoon is removal, destruction and stabilization of organic matter; it is not water purification.

Aerobic Lagoon

Mechanically aerated lagoons are being developed. An aerobic lagoon requires free oxygen. To insure this, air is mechanically incorporated in the liquid waste.

The primary benefit of the aerobic lagoon is that the process is essentially odor-free. As with the anaerobic lagoon, degradation of organic matter is about 50%. Other benefits of this system, as with the anaerobic lagoon, are the low odor of the sludge and the value in combination with other treatment practices.

Limitations of this system are that:

- large amounts of dilution water must be added to produce a desirable aerobic medium

- freezing temperatures may cause operational problems
- biological activity is limited in cold weather
- periodic cleaning of solids from the lagoon is necessary.

The aerobic lagoon can find application in water purification if this must be an ultimate goal in farm waste management. Several aerated lagoons placed in series can produce a high quality effluent. One or more aerated lagoons following an anaerobic lagoon can have the same result. Similarly, the aerated lagoon may be used in combination with other procedures as a final polishing unit to give a high quality product.

Naturally aerated lagoons are used successfully in warmer climates in conjunction with wastes less concentrated than livestock manure. Although it is possible to employ them, in our climate the large size necessary, the large amounts of dilution water needed and the seasonal application are probably too restrictive except in very special cases.

Oxidation Ditch

The oxidation ditch is probably the most actively researched method of livestock waste handling and disposal at this time. This aerobic unit functions much like the aerated lagoon, but its design and operation make it highly desirable in conjunction with many confinement livestock production facilities. Like the aerated lagoon, it is highly desirable because it can be essentially odor free. The two primary parts of the oxidation ditch are (1) a continuous open channel, shaped like a racetrack, that holds the liquid waste, and (2) an aeration rotor that supplies oxygen and keeps the channel contents circulating.

The first reported use of this procedure with livestock wastes was in 1966. The oxidation ditch itself was first reported in 1963. It is evident that the progress made in the development of this unit has been rapid.

Research at a number of midwest universities has brought the oxidation ditch to the forefront as a procedure for handling swine wastes. The system has met with enough success to be recommended as a dependable procedure. Detailed information on design, construction and operation is available.

The use of the oxidation ditch with cattle and poultry wastes is now being investigated. The research is in the preliminary stages and little evidence of success or failure is available. Cattle, particularly dairy, and poultry will probably offer greater challenges to the system due to the characteristics of the waste. But experience gained in developing the system for swine will be very beneficial.

Though the oxidation ditch as a treatment practice for swine waste is effective, it is not perfect. The treated waste is not pure enough for discharge to a stream (90% removals of the biochemical oxygen demand have been reported). Some liquid and some solids remain after treatment and must be returned to the land. Periodic maintenance of the equipment is required.

The primary operational problem has been foaming, which commonly occurs when the system is put into operation and when it is overloaded. Commercial defoaming agents can be used at these times to eliminate the hazard of excess foam accumulation, but close observation and competent management can prevent the problem from occurring in most cases.

Composting

Composting is a waste treatment method suited more to a solid waste system. This practice requires time and equipment that is beyond the capabilities of most livestock producers.

Composting of dairy and beef cattle wastes and of poultry wastes is reported. But a suitable market for the product must be available before the practice can be considered practical. Though isolated installations may be successful, it is doubtful that sufficient market exists for the volume that could be generated by a large section of any state.

In-place-composting has been reported. By this procedure poultry litter was composted within the poultry house after the broilers had been removed. After composting the litter, it was spread again for use by the subsequent batch of birds.

Land Application

This section deals with the application of manure to the soil as a means of treatment and disposal. Technically all the methods discussed previously depend ultimately on the land for disposal, but primary treatment depended on other media.

Land disposal is still the most widely used livestock waste disposal procedure. It will continue to be so. Land disposal is truly a treatment and disposal system. The filtering capacity and the microbial flora of the soil treat the waste in a superior manner. Nutrients are made available for plant use and humus works as an effective soil conditioner. Disposal may be somewhat of a misnomer since the waste components are used for the benefit of the soil and crop growth. Disposal may be more properly applied to a procedure such as landfilling (disposal without utilization) which has little application now for the disposal of livestock wastes.

Present research is checking the effects of manure on crop yields, on soil qualities, on crop composition, on soil water and on interactions with applied inorganic commercial fertilizers.

Storage of liquid manure is becoming more common. Storage of manure is different than practices that require storage for treatment or reduction of the waste to take place. Storage, with little or no dilution, focuses on conservation of the nutrient value of the manure with utilization through land application. The types of spreaders used for solid and liquid manure are familiar.

Recent research in Wisconsin has shown that significant benefit may be derived from the soil conditioning value of livestock manure. Too many past analyses of the benefits of livestock manure have dealt only with the plant nutrient content. Though this soil conditioning value may not apply equally well to all soil types, its benefit for some soils is obvious and should spur new interest in the use of land application as a practical and economical form of livestock manure utilization.

Irrigation is being tried as a method of land application of liquid wastes. It is being used to dispose of the liquid supernatant on aerobic and anaerobic lagoons. This can be very useful if it eliminates discharge from the lagoon. A portable irrigation system can effectively reduce the labor required for ultimate disposal of the liquid waste.

The system must be considered seasonal because of expected maintenance problems and frozen waste build-up during the winter. Another limitation of the irrigation system is its limited capacity for disposing of solid manure. Although the equipment will carry and distribute most solids in livestock manure, dilution water in the amount of three to ten times the original volume of the waste must be added for desirable irrigation consistency. Such water quantities would be unavailable on many livestock farms.

A different type of equipment being developed for land application is the plow-furrow cover (PFC) apparatus. It usually consists of a tank wagon following a one-furrow plow. Liquid manure is distributed in the open furrow and covered immediately by the new furrow slice. This procedure offers maximum protection against production of offensive odors and pollution of surface runoff water. Maximum utilization of plant nutrients can be realized. A properly adjusted one-furrow plow can cover liquid manure at rates up to 200 tons per acre. The coordination of plowing operations and spreading of stored manure requires careful planning.

CHEMICAL TREATMENT

The procedures for treatment and disposal of livestock manure discussed up to this point have been biological in nature. Chemical procedures have also been used in animal manure treatment. Early chemical applications were made in conjunction with biological processes. Lime, chlorine and other oxidizing agents were used in an effort to control pH, regulate odor production and condition the sludge in manure treatment practices. More recent chemical applications are toward complete treatment by chemical and physical means. These procedures, though the field is just now opening up, hold some promise of practicality when reutilization of the processed waste is anticipated.

PHYSICAL TREATMENT

Incineration and dehydration are two physical processes that have received some attention as means of disposal of livestock manure. Of the two, dehydration seems to hold more promise since the dried product is

useful. Research and application presently in progress use the dried product as a soil conditioner and as livestock feed.

Incineration has received less attention than dehydration. The product of incineration is ash. Both incineration and dehydration have the advantages of great reductions in the amount of product to be handled. These processes also minimize water pollution problems. Air pollution however is an inherent problem in both schemes and calls for adequate control procedures.

COPROPHAGY

Coprophagy (the feeding of dung) is being studied as another method of livestock manure utilization. A number of projects are in progress. These projects are measuring the ability of poultry and ruminants to utilize the feed value of appropriately treated and processed livestock manure. The typical manures being fed are poultry manure, poultry manure with litter and beef cattle manure from animals on roughage and on concentrate rations. Initial results indicate that livestock is indeed able to reutilize the feeding values in manure and reduce the cost of other feeds required. Meat products have no off-flavor. This practice has public health implications that will require extensive study before general practice could be acceptable.

GASES AND ODORS

Gas and odor production was of little concern until farmers started storing liquified manure to improve its handling characteristics. Gases and odors are a product of biological activity. They increase in intensity with an increase in moisture content and with an increase in storage time.

Since there are advantages to using liquid manure systems, researchers are working to understand more fully the process of odor and gas production. Greater understanding of the nature and source of the offensive components is necessary to attack the problem from a position of knowledge rather than chance.

The principal gaseous products of liquid manure storage are ammonia, carbon dioxide, hydrogen sulfide and methane. These gases are offensive because they are produced in significant volume. Their presence is dangerous to men and animals because ammonia is an irritant, carbon dioxide is an asphyxiant, hydrogen sulfide is a poison and methane is an explosive. Damage and death attributable to the presence of these gases are on record.

It should be pointed out that, during normal operating conditions, concentrations of the above mentioned gases are well within safe limits. But special precautions and a thorough understanding of the problems are necessary when critical situations such as power failure or removal of stored liquid manure develop.

Odors, with the exception of hydrogen sulfide, are more of a nuisance than they are harmful. Odorous components arising from stored liquid manure include ammonia, hydrogen sulfide, amines, volatile acids and mercaptans. The latter three, though generated in lesser quantities, have penetrating and tenacious qualities which make them highly significant.

Research in livestock manure disposal is now concentrating on further and more complete identification of odor producing components and on methods of controlling odor by treatment before or after the odors are produced. Odor analysis, whether it relates to strength or quality is subjective because most results are based on the response of the human nose. Individuals vary considerably in their ability to detect certain odors and in their judgments of the "disagreeableness" of these odors. Reports often include such nebulous phrases as "objectionable odors were not prevalent". It is difficult to draw a sound conclusion from such evidence.

Understanding of the process of odor production is still severely limited and the solution of odor control problems depends heavily on trial and error procedures.

SOLID MANURE WASTE

Solid manure waste has received little research attention in recent years. This perhaps is a silent recommendation for the procedure in light of the pressure to solve the problems created with the advent of liquified manure.

Research presently in progress in Wisconsin relates to long term storage of solid manure. Though few research reports are devoted exclusively to solid manure, its importance can be seen in the progress of related research. Dehydration and coprophagy require solid manure as the basic raw material; handling and removal of excess water is wasteful. The same applies to the process of composting.

Another approach to handling animal manure is that of further solidifying the manure by removing water. This approach is opposite that of fluidizing. Since fresh manure is 70 to 90 percent water (actually more semi-solid than solid) this approach is reasonable. The advantages of removing water from animal manure are:

- it changes the handling characteristics.
- it reduces the weight and volume.
- it reduces the offensive odor.

This review is of necessity brief. No attempt is made to report on all engineering research in the field of animal manure and no attempt is made to report details of the research work. Review is limited to that research felt most applicable to Midwestern and, more specifically, Wisconsin conditions. Further information on most of the projects reported may be found in the reference list at the end of this paper.

CONCLUSIONS

1. The anaerobic lagoon can best be utilized in combination with other treatment and disposal practices.

2. The aerobic lagoon, though more effective in odor control, offers little advantage over the anaerobic lagoon. It should be used in series or in conjunction with other practices for livestock waste treatment.

3. The oxidation ditch can be used successfully for swine, but its use for wastes from other livestock is still uncertain.

4. Composting, though effective, lacks sufficient market demand to be seriously considered as a method of waste treatment and disposal.

5. Land application has been and will continue to be the most widely used type of livestock waste disposal. New interest in this procedure should be generated because of recent work which indicates the value of manure as a soil conditioner in addition to the value of plant nutrients present.

6. Irrigation looks promising as a means of disposing of liquid wastes.

7. Plow-furrow cover application of manure can optimize use of field-applied manure and elimination of field odor and runoff problems.

8. Chemical treatment, dehydration and coprophagy are now being studied, but to date no conclusions have been drawn.

9. Odor and gas production in livestock manure is not well understood and control is an inexact science.

10. Solid manure, because of the lack of problems associated with its handling, deserves serious consideration in any animal waste handling situation.

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NATION-WIDE RESEARCH ON ANIMAL WASTE DISPOSAL

Jacob O. Dumelle*

Last August a group of very "non-hippie" adults picketed the Chicago office of the U. S. Steel Corporation a day before the Calumet Enforcement Conference opened. They carried signs reading "Save Lake Michigan" and "Clean Up The Water". These people then attended the conference to testify, and they were very well versed in the problem.

Minnesota and Vermont are presently engaged in a joint legal action with the Northern States Power Company in Minnesota, because Minnesota is trying to set more stringent levels on nuclear wastes than the Atomic Energy Commission has set. The case is attracting national attention because the question involved is "Can the states set more stringent standards than the Federal government?"

The California legislature has almost passed a bill banning internal combustion cars as of 1975. By January or February of next year, all jet aircrafts must have afterburners to eliminate black smoke. About 12 states have recently issued standards for sulfur dioxide and suspended particulate in metropolitan areas under the new air pollution regional standards program. Canada wants the phosphates taken out of detergents as soon as possible. Sweden has just banned DDT.

The whole public focus is, as never before, on environmental pollution control. The trend is to demand cleanup now -- not later. Even politicians are getting deeply involved, and that only happens when the public demands it.

We, in the Federal Water Pollution Control Administration, are doing some research and hope to develop some alternatives. We are also providing funds, up to 70% grants, to help support several demonstration and research projects. Most of the projects have just been started this year and the results will not be out until next year or later.

One such project, to which we donated $64,000, is underway in California. The Department of Water Resources is trying to determine the practicability of producing and harvesting algae to remove nutrients from agricultural drainage waters. This ties in with a new sewage treatment process developed by Dr. Ross McKinney, who calls it "activated algae". McKinney says algae can be raised in sewerage treatment plants in tanks designed for photosynthesis. This process accomplishes secondary treatment and also removes nutrients as the algae is harvested. Disposal of the algae is another problem, but it can perhaps be used for feed.

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Several other research projects are still in the negotiating stage. For example, the Agricultural Research Service wants to compare the chemical and organic pollutants entering the atmosphere, soil, and surface and underground waters at two cattle feedlots. One feedlot would be in northeastern Colorado, an area of low precipitation; the other would be in eastern Nebraska where the annual precipitation averages 28 inches (about the same as Wisconsin).

Another project is being considered in Maryland where a dairy farm hopes to demonstrate methods of treating dairy farm waste waters on a fill and draw basis in a biological system. The system would consist of an aerated grit separator, an aeration tank, a blower and pump building, a chlorine contact tank and so on, just like a sewage treatment plant.

Another project may be conducted at Ohio State. Waste taken from a 500-pig confinement would be run through an oxidation ditch and recirculated as a flushing water. Washington State University is planning a study of anaerobic and aerobic lagoon treatment of dairy waste manure. The University of Kansas wants to do research on anaerobic and aerobic lagoon treatment of cattle feedlot waste.

Besides research on treatment methods, some projects are trying to find how much nutrient runs off, how much goes into the water and so forth. South Dakota State University's project is "Quantification of Pollutants in Agricultural Runoff". The Water Resources Research Institute of North Carolina State University, Raleigh, is conducting a project called "Assessing Water Quality Drainage from Small Watersheds" and relating it to confined and unconfined animal dwellings.

This will give you an idea of what we are involved in. We realize animal wastes are a big problem and we are doing all we can to help. Recently we published a bulletin called "Pollution Implications of Animal Waste--a Forward Oriented Review." You can obtain a copy by writing to:

Federal Water Pollution Control Administration
33 East Congress Pkwy.
Chicago, Illinois 60605

WATER RESOURCES CENTER RESEARCH ON ANIMAL WASTES AND WATER QUALITY

James E. Kerrigan*

The University of Wisconsin's active participation in research in the areas of agriculture and natural resources is well known to the participants of this conference. Several departments have in past years participated in individual studies or in joint undertakings on research and have contributed significantly to the problems faced by the state. It would be interesting to review some of the early experiences, but lack of time prevents such an historical review.

The purpose of this conference, as has been impressed upon us by the earlier speakers, is to expose the problems, identify the opportunities and raise questions facing Wisconsin and the midwest states, which will assist in the development of programs and methods for the management of farm animal waste.

In recent years there has been a growing public awareness of the effect man's activities are having on his environment. This recognition has prompted many concerned citizens to ask for federal, state and local government action in abating pollution of the water, air and land resources of the nation. The handling of farm animal waste can potentially affect all three areas--water, air and land--if adequate management practices are not followed.

The Water Resources Center is a relatively new organization in the University, and was organized in response to the interest in developing a comprehensive research program on water.

The University has been actively involved in interdisciplinary research in the water fields for over 30 years. A faculty committee on ground water was the first formal group instituted, and in 1946, a committee on lakes and streams was brought together for research. In 1963 the all-University Water Resources Committee was appointed and assigned the responsibilities of the older committees. It was upon the recommendations of this committee, which had representation from several disciplines, that the University established a Water Resources Center within the Graduate School. As organized, the Center was designated as the state unit responsible for administering the federal research grant program authorized under the Water Resources Research Act of 1964 for Wisconsin.

Subsequently, the Water Resources Center was assigned state responsibility by the legislature for the coordination and administration of an interagency water resources research and data collection program (6,S). The statutory instrument establishing the Center's participation in the

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program is provided under Section 36.245 and 36.30 of the Wisconsin Statutes. The program calls for applied research and data collection to assist the line agencies in the state in coordinating, developing and managing the state's water resources.

In connection with this objective, the agencies are (1) identifying more clearly the misuse and inefficient allocation of water related resources, (2) accumulating information to develop practical solutions to problems and (3) indicating ways for the conservation or optimal use of the state's resources.

A constant effort has been made to match the best talent available in the state to the projects of highest priority within the limits of the program budget. Flexibility within the program has been maintained in several areas. To meet the state-wide requirements for base data, it has been necessary to develop monitoring and field-survey programs that require long-term planning.

Originally funds for the program were authorized for five state agencies. The number is now three divisions in two agencies as a result of the recent reorganization of state government. In addition to authorizing funds for agencies, the Act designated the Director of the Water Resources Center as Coordinator for the Program.

In the 1968-69 biennium, the following appropriations were allocated to state agencies in the amounts shown:

1. Department of Natural Rescources. $451,000

    a. Bureau of Research ($200,000)
    b. Division of Environmental Protection ($251,000)

2. University of Wisconsin, University Extension,
   Geological & Natural History Survey $230,000

Each of the agencies has gone beyond its own organization to obtain the special talent of individuals or groups in the University of Wisconsin or in state and federal government to conduct specific projects or assist on phases of the program. Channels of communication have been developed to acquaint the faculty of the University with the program, thus giving potential investigators the opportunity to undertake specific studies. More than 30 faculty and graduate students from nine departments in the University have participated in some phase of the joint program, not counting individuals in the State Geological Survey.

Several meetings have been called to give joint consideration to respective phases of the program, and the Water Committee of the Natural Resources Council of State Agencies has generously given advice to the Director of the Water Resources Center on merits and priorities of individual projects in the program.

Support has been granted to develop a reference collection of current research reports at the Water Resources Center. The collection is

catalogued under a modern data retrieval system and is available for use by University and government agency personnel or the interested citizen.

A number of training programs are available in civil engineering, limnology, hydrogeology, soil science, water chemistry, regional planning and natural resources economics that are specifically designed to prepare specialists in the water field. In addition to granting graduate degrees in the traditional departments, the Graduate School offers an interdisciplinary degree of Master of Science in Water Resources Management.

The Federal Water Pollution Control Administration sponsors a large number of research fellowships and traineeships at the University of Wisconsin and provides support for research, especially in the area of studies on eutrophication (over-enrichment) of natural waters. On May 21, 1965, the Center was awarded initial research funds under provisions of the Federal Water Resources Research Act of 1964. The federal government, under Public Law 88-379, administered by the Office of Water Resources Research, Department of the Interior, approves requests for funds. The bulk of these funds are directed toward the support of non-contract research projects which require the professional abilities of several disciplines. The Center is eligible to receive $100,000 annually toward the support of the Center's activities.

The Center has recently developed an active Eutrophication Program. The program consists of a multidisciplinary research effort on several facets of the over-enrichment of lake waters. Coupled with the research is a eutrophication information collection and dissemination activity, which gathers useful information, processes it into a useful format such as abstracts and makes it available nation-wide.

In keeping with present policy and the current activities, an outline of functions of the Water Resources Center is as follows:

1. To plan, propose and guide interdepartment research on water, which calls for integrated work by persons from diverse disciplines.

2. To improve and develop graduate curricula dealing with the physical, chemical, biological, economic, legal and social aspects of water resources.

3. To publish and supply water research findings to governmental and non-governmental entities.

4. To collect in a working reference room current water research materials and an inventory of current water research and its progress.

5. To conduct water research seminars and conferences for water specialists from state, local and federal agencies, the private sector of the economy and university staffs.

6. To provide for the coordination and administration of federal and state water resource programs that can be furthered and enhanced by interdisciplinary academic participation.

Concerning programs related specifically to farm animal waste management, the Center has participated in supporting one multidisciplinary project on "The Nitrogen Cycle in Surface and Subsurface Waters" through a matching grant from the Office of Water Resources Research, U. S. Department of the Interior. Principal investigators on the project represented four separate disciplines, namely agricultural engineering, bacteriology, civil engineering, soil science and water chemistry. Professor S. A. Witzel from the Department of Agricultural Engineering, chairman of the principal investigators, coordinated the numerous studies that were conducted under the multi-project Farm Animal Waste Disposal Study. Several of the results developed from these studies have been reported on at this conference, and more information from these studies will be disseminated in subsequent meetings. Field studies are still underway and seasonal data developed by the project is undergoing close analysis.

The meeting here today will make more relevant the research program in the area of farm animal waste management if the audience will participate in identifying problems that are in need of study. Because many of you are, as they say, "out in the firing line", your insight and instruction is especially valuable in identifying critical situations and conditions that result from farm animal waste disposal.

If Wisconsin is to have a well-balanced research program for water quality management, it is necessary to direct the limited available financial support to researchers with specially developed talents to solve specific problems that merit consideration. With the abundance of problems facing us and the scarcity of funds and qualified personnel to conduct adequate investigation, we must expend a generous amount of effort to identify the real problems, which will allow us to concentrate on the "heart" of the matter.

Your time and effort spent with us in identifying the critical problem areas are welcome. Without your participation the state's research program has less chance of meeting the present and future needs of Wisconsin's environment.

THERE'S HOPE AHEAD

John Skinner*

In my opinion the future of animal agriculture depends on our ability to find and put into practice socially acceptable, economically feasible solutions to the problem of environmental pollution that occurs from intensive animal production units. I'm sure none of you will disagree with that. But the question is, 'Will we do anything to bring this about, or will we pick at it until what was a good idea becomes only so many words?"

Now my assignment isn't exactly to ruin your dinner and I surely hope it doesn't turn out that way, but I do have to get your attention focused on some facts. Consider for a moment the glass of water that you had with your meal tonight. How many times has that water been used and for what purposes in the past 2,000 years? Kind of frightening isn't it?

Several years ago I was involved in planning the First National Symposium on Poultry Industry Waste Management and even we on the committee sometimes snickered when someone in the group described the excrement of chicken in particularly picturesque phrases. We have come a long way since then. Now a thesis on feces no longer gets a laugh. In fact, some say, 'Why not? It may be in keeping with the author's (or his institution's) general output". After all, wouldn't it be appropriate if it were to lead to a Ph. D. degree--perhaps a "Doctor of Dung." This could lead to all sorts of employment possibilities like, Dean of the Latrine (for you ex-G.I.s) or Supervisor of Seepage, Effluent Examiner or perhaps President of the Privy Council, Captain of the Head, for some of you ex-Navy men.

Well on to the chores. Economists always prove their point with figures. Now I'm no economist, "Heaven forbid!" But I am intrigued by the thought of what you might call an economist who deals in fecal relocation economics. Perhaps he would be a "Super Duper Pooper Scooper".

But let's try a few figures. There are 30,000,000 cats in the U.S.A. --and an adult cat will void about 2 oz of feces per day, I'm told. Now in just one week that adds up to 13,125 tons of cat s-s-s signatures. Ah, but what has happened? An industry, (kitty litter) has developed, and they found some other uses for it too--(garages).

You see there is "Hope Ahead."

There are many examples of wide-awake people making thriving industries out of problems. Take our cosmetic industry for example. Much of it is based on the fact that the human body has odor. We can wash it away, we can cover it up or we can beat it down, but our fellow beings

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won't let us ignore it. As a result some very profitable industries exist today.

With population increasing at the rate of 142 people per minute world-wide and our land being lost to agriculture at a rapid rate (5 acres per minute of every day), we can anticipate only one thing. Man and animal will live in ever greater numbers and in ever closer proximity to each other if we continue our present patterns of eating.

All animals, regardless of the species or the way they are managed, have characteristic odors that we must consider. When we concentrate the numbers of animals in a unit or given area, the result is noticeable in the form of odor in addition to the accumulation of fecal material, urine, dust, noise, etc. Good management cannot eliminate natural animal odors. Bad management may intensify them and even cause other odors.

The point is simply, if we want reasonably priced meat in good supply, we must have large efficient animal production units with huge quantities of air moving through them. This air will smell.

"Now if you are not accustomed to the odor it may be offensive to you." This is an accepted fact (regardless of its source).

Let's take one of the broiler houses at A.G. Coop at Arcadia. On a warm day as much as 308,000 cubic feet of air per minute are moving through. This air has some odor where it emerges from the fans. Of course, Doc Burch says, "Them damn chickens stink!" and to some he's right. But Jim Crowley smells a little different when he comes out of a cow barn than when he went into it. The point is simply that if an odor is foreign to you, it may be objectionable. As more and more of our population live away from daily contact with farm animals, we can expect to see more turned up noses and offended people.

The public doesn't care what we do with manure. It's the odor that bothers them. We have the technology for doing many things with manure. For example, we can:

- fertilize land
- heat houses, hotbeds and incubators (the heating of incubators by decomposing manure is the first commercial use of manure)
- digest it for production of gas
- dehydrate it and use it as chicken feed
- blend it and feed it to ruminants
- bury it
- burn it
- composite it and sell as fertilizer

- blend it into other fertilizers
- dehydrate and package it for later sale
- feed fish and fertilize ponds

If feathers are the problem, they can be:

- used as fertilizer
- processed into a feed supplement
- used for insulation
- processed for clothing
- used in ornamentation

Odors can be washed from the air, masked with other compounds, absorbed on or in filters, burned with high temperatures, reduced with chemicals or diluted with water. We have a lot of technology but it is the economic limitations that prevent many of these systems from being widely used.

So we can clearly see there is hope ahead because American Ingenuity sooner or later solves most of the economic challenges that confront it -- even to the control of inflation? Well, partly anyhow.

There is hope ahead because people will, in fact are, demanding a solution. We, as animal production people, can meet these demands, but only at a price. So, now the problem is one of economic compromise between the absolute ideal and that which is economically feasible. <u>It behooves each and every one of us to impress this fact on the total public</u>. Make no mistake. It won't be simple. But it can and will be done. It must be done. The alternative to failure may well go beyond just higher prices for meat. If we do not solve the environmental effect problems from intensive animal production, we may well have to resort to all vegetable or even to synthetic diets within this century.

The idea of discussing and writing about manure handling systems is by no means new. Columella in his writings "On Agriculture", penned in the early part of the first century, describes the placement of equipment so that droppings would fall at the desired spot. The Farmers Almanac of 1813 has a detailed article on liquid manure handling. Therefore, we need not hesitate or avoid this subject because of its newness or assume that because others have not solved the problem of the environmental contamination, it won't be solved.

What we must do is recognize that the problem is one of numbers and closeness. It is brought about by an increasing number of people and their desire for good, wholesome, low-cost food. This means that we must have large efficient production units. We cannot get product uniformity and repetitious quality in the required volume from a myriad of small producers.

The prices that we have come to expect (29 cents/lb. for fryers as an example) are dependent on maximum efficiency in large, concentrated units. We have all benefited from the availability of such foods, and if we want this situation to continue, we will have to fit such units in as an acceptable part of our society. Oh, we may have to change them a bit; perhaps discharge the air above human noses, surround the buildings with groves of trees to absorb fan noise and odors, make sure that feathers don't blow out of the trucks on the way to the processing plant, etc. But these changes can be made.

So how do we proceed? First I believe we must each dedicate ourselves to finding the answer. It's too important to leave to someone else and no one man or agency is going to be the sole answer. It must be a total effort of many people. Also we must realize that laws won't in themselves be the answer. Just as leash laws haven't succeeded in keeping my lawn free of dog stools, although I don't have a dog, neither will laws on waste disposal enable us to forget that it is a problem.

To proceed effectively we must have full realization and appreciation of the cause, extent and consequences of the problem by all concerned. (Belgian example--"Pollute? We have no pollution problems. We just run it in the canal.") We must formulate regulations and laws that are progressive in nature but that consider the economic consequences as well as the esthetic desires. We can easily go so far and so fast that we put the price of meat, milk and eggs above the ability or willingness of our consumers to pay.

We will need better land use planning. Individual agriculture producers cannot afford to provide their own "buffer zones" even if the land were available, not at least if they are to provide low-cost, high-protein foods of animal origin. Likewise, taxes, in themselves, should not be permitted to take a farm out of production. Look at England's Green Laws as examples of land use protection.

We need a better image for agriculture and agriculture production, and I hope that members of the press and news media will help us. Animal agriculture must be recognized as a prestigious occupation, on a par with that of any business or profession.

We must create better public relations for all of agriculture and agriculturally related industries. This must include the industries that support agriculture and the agencies that regulate it.

<u>We must constantly look forward to the consequences of what we are doing today</u>. This is especially true in the area of laws and regulations. In other words, "What will happen tomorrow because of what we are doing today?"

Also, I am firmly convinced that hopes are achieved most frequently by those persons who set goals for themselves. I would like to propose that our goal be, "<u>To render inoffensive those parts of animal waste and by-products which are disagreeable to the public in general</u>." Not you or me, but the public in general. We can't fight 'em and it won't do any good to cry.

Yes, there is hope ahead because you and I are on this job, and I'm egotistical enough to say that we can do it. But make no mistake, it will take determination and vision, and that reminds me of a story some of my English friends were telling me last week. It seems that a snail was climbing a cherry tree in the Fall of the year and a bird flew by. "Mr. Snail," he said, "Why are you climbing that tree? There are no cherries on it now." The snail replied, "Ah, but there will be by the time I get there."

INTRODUCTION TO FEDERAL, STATE AND LOCAL ACTION PROGRAMS TO SOLVE ANIMAL WASTE DISPOSAL PROBLEMS

Douglas A. Yanggen*

In recent years we have seen a dramatic increase in discussion and controversy about the pollution of our physical environment. The agricultural industry and rural people are directly involved both as polluters and victims of pollution. This conference is focused on one aspect of agricultural pollution--animal wastes. There are others, such as sediment and pesticides. It is not the purpose of this conference to discuss municipal, industrial and other sources of pollution. We must recognize, however, that protecting the quality of our physical environment involves much more than reducing pollution from animal wastes. If we are to solve this problem, we cannot do it in isolation from the broader issues.

In a general sense, environmental management consists of millions of decisions made by individuals and organizations. In a narrower sense, we attempt to manage the quality of our environment through collective action. One way we do this is through governmental programs which influence the decisions of individuals, firms and groups. These programs make use of various devices such as subsidy, technical assistance, regulation and education.

We are going to look at governmental programs which include technical assistance, cost-sharing, regulation and education at the federal, state and local levels. It is not possible here to discuss all the relevant governmental programs. Those included, however, are major ones and illustrate the various techniques for influencing private decision making.

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THE ROLE OF THE FEDERAL WATER POLLUTION CONTROL ADMINISTRATION IN FARM ANIMAL WASTE AND THE BY-PRODUCT MANAGEMENT

Frank E. Hall*

Wastes from sources related to agricultural activities are now recognized as major contributors to water pollution. The extent and intensity of these wastes has not yet been fully determined, but there is enough evidence to indicate that they rank along side municipal wastes and industrial wastes in terms of both quantity and effect. The production of farm animals provides water polluting wastes that in some states exceed those from the human population.

The volume of wastes from livestock and poultry production in the United States is estimated at 1.7 billion tons annually. About half this amount is produced by animals in concentrated production systems. The degree of concentration and the size of individual production units are increasing rapidly. This trend permits greater efficiency in the production of animal products, but it also generates a greater concentration of animal wastes and results in the need for new technology to handle and dispose of these wastes in a manner that is compatible with the water quality standards each state has developed.

In passing the Federal Water Pollution Control Act, Congress declared its policy to (1) recognize, preserve and protect the primary responsibilities and rights of the states in preventing and controlling water pollution, (2) support and aid technical research relating to the prevention and control of water pollution and (3) provide Federal technical services and financial aid to state and interstate agencies and to municipalities. Enforcement measures against pollution of interstate or navigable waters are also provided.

The programs of the Federal Water Pollution Control Administration (FWPCA) are designed to implement that policy, and I would like to discuss briefly how those programs relate to farm animal wastes and by-product management.

The research and development program has been active in seeking solutions to the problems of animal waste disposal. The following are examples of government and in-house research activities:

- An FWPCA grant has been made to Washington State University to study and produce a high protein-laden algae food supplement from dairy cattle manure and runoff.

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- Studies at Kansas State University are characterizing beef cattle feedlot manure and runoff in order to use existing techniques for effective treatment of wastewaters.

- The FWPCA is determining the effectiveness, design criteria, engineering problems and related costs of various pollution control systems involving the handling, treatment and disposal of manure and storm water runoff from large concentrated animal feeding operations.

- A grant to Michigan State University supports the investigation of a self contained, automated animal waste management scheme that is capable of fractionating animal waste into its liquid and solid components, which will not cause aesthetic or pollutional problems after processing.

Comprehensive programs for water pollution control are provided for by the Water Pollution Control Act. They must give due regard to all legitimate uses, and agricultural uses are specifically referenced. Along with the concern for assuring agricultural uses, there is the charge that programs be prepared or developed for eliminating or reducing water pollution and improving the sanitary condition of surface and underground waters.

The program specially devised for the Lake Ontario Basin by the FWPCA, in cooperation with the state of New York, recommended that agricultural practices be improved to attain maximum protection of waters against fertilizer residues, manures, pesticides and soil erosion material. It said that organization and funding of soil conservation districts should be encouraged.

The Lake Erie plan for water pollution control noted that agricultural sales in the United States portion of the Lake Erie Basin approach $1 billion annually, over half of which is livestock. That plan called for state and federal agricultural agencies to begin or accelerate programs to control sediment loss, oxygen-demanding substances and fertilizing agents from animal feedlots and farmland runoff.

Closer to home, similar concerns have been expressed and recommendations made regarding the Lake Michigan Basin. However, since Lake Michigan has been the subject of a recent enforcement action, I will comment on that in a few minutes.

The FWPCA has activities supporting all the elements of water pollution control, but I wish to mention those that relate directly to the control of pollution from farm animals.

Pollution surveillance and special studies have for years provided valuable background information on pollution in our streams and lakes. The sources of pollution are found. The types of wastes are identified. And the extent of pollution is discovered. Without this information, constructive programs for control are not possible.

The states have been very active in such water quality monitoring, as they have been in the other elements of a good water pollution control

program. And the FWPCA promotes and encourages the states to expand and improve their water pollution control programs to include appropriate concern and action on agricultural pollution problems.

State water pollution control programs are supported in part by federal grants. When applying for those grants, the states are asked to describe any special monitoring program for agricultural wastes, any studies of special pollution problems such as those caused by livestock feedlots, and any feedlot regulations or other controls issued to correct and prevent such pollution. In reviewing the state programs and making those grants, the FWPCA expects the states to include recognition and activities appropriate to their animal waste management problems.

The water pollution control plan for the Wisconsin Department of Natural Resources notes the changing pattern of livestock rearing and the expected problems, and calls for the development of technically acceptable and economically acquirable disposal treatment facilities for manure. The plan also identifies seven units of the Department of Agriculture that have a major interest in water resources.

The measures for enforcement provided by the Water Pollution Control Act have resulted in 46 enforcement actions across the country. A number of these proceedings have taken particular note of the agricultural pollution problem. The enforcement actions begin as conferences, and the parties to those conferences are the states having jurisdiction and the Federal government. The law provides for final action in the courts, but successful programs have usually been worked out at the conference table.

At the second meeting of the Lake Erie Enforcement Conference, the conferees called for a meeting with officials responsible for agricultural programs to control runoff which deleteriously affects water quality in Lake Erie. At a later session, the conferees specifically requested the U. S. Department of Agriculture to report on a program to protect Lake Erie from agricultural runoff and associated pollutants. A general report was recently presented, and it was believed by some conferees that a more specific program was needed. The state conferees concurred in the recommendation that more adequate funding be provided to the soil conservation districts and the watershed programs in the Lake Erie Basin.

At the first session of the Lake Michigan Enforcement Conference, the conferees recognized the need for programs to prevent pollution from agricultural land use. Wisconsin, Illinois, Indiana and Michigan, along with the FWPCA, are parties to that conference. At the second session of the Lake Michigan Enforcement Action, the FWPCA recommended that the state agencies ". . . report on the pollution problems they may have, caused by agriculture, in the Lake Michigan Basin, and the programs, if any, that are available, or would be necessary, to alleviate the problems. Further, the states should report on whether the cattle feedlots constitute a pollution problem." It was proposed that a committee be established to accomplish this and to make specific recommendations to the conferees on agricultural pollution problems.

Finally, I wish to tell you about what is perhaps the most significant recent accomplishment in water pollution control. That is the establishment of water quality standards. In 1965 Congress passed a law requiring that standards of water quality be established on all the interstate waters of the United States. Although the Federal government is a party to the newly established water quality standards and has power to enforce them, the state water pollution control agencies are primarily responsible for their development and enforcement. Each state has held hearings and determined the desired uses for its interstate waters, then established appropriate standards of quality and devised a plan to assure that the quality desired is achieved.

Many states that have a large agricultural industry, clearly identified in their water quality standards the need for studies and programs to control farm animal wastes to assure that the established standards are met. Wisconsin's water quality standards discuss agricultural wastewaters. And Wisconsin and many other states have continued the process of establishing water quality standards to include intrastate waters. Thus, all the waters of the state have standards of quality that will protect and preserve those waters for all legitimate uses today and in the future.

In closing, I would urge anyone interested in farm animal and byproduct management to become well acquainted with the Federal-State Interstate Water Quality Standards and the state's intrastate water quality standards. I ask this so that your efforts will be well directed to preserve our water resources.

TECHNICAL ASSISTANCE AVAILABLE FROM THE SOIL CONSERVATION SERVICE

Jack Densmore*

For about 35 years the Soil Conservation Service has been involved in providing technical assistance to landowners on soil erosion control and sediment reduction in Wisconsin. Many of the same techniques used in erosion control are effective in reducing pollution from farm wastes, once those wastes are applied to the land.

Soil conservation practices that minimize surface water runoff are the best possible protection against dispersed contaminants. Complete conservation treatment of a watershed reduces surface runoff, causing much of the water to be absorbed into the soil before it reaches stream channels as base flow.

Conservation measures can, no doubt, be further refined to reduce pollution from farm wastes, just as they have been adapted to other changing purposes of land use in the past.

The Soil Conservation Service has personnel well trained in soil conservation, and they are backed up by technical specialists in conservation engineering, soil science, agronomy and biology. These areas of expertise can have application to the problems of farm waste disposal.

Technical assistance might be useful for:

- Helping landowners eliminate grazing of streams and lakeshores. This often calls for changing field and pasture boundaries, moving fences and providing stream crossings.

- Helping landowners keep runoff water, from lands lying above the barnyard or feedlot, from running through the yard or lot. This may involve diversions, waterways, or even, in the right situation, a detention structure. It may mean regrading or relocating yards.

- Reducing losses of manure spread on fields. This may include pointing out the least erosive areas on the farm for use when the ground is frozen. In areas where manure must be spread in the winter, the landowner might consider practices such as cover crops or parallel tile outlet terraces with blind inlets.

- Handling runoff waters from barnyards and feedlots. Perhaps runoff can be diverted over well-vegetated areas to use the filtering effect of such vegetation. In some cases a storage lagoon with a sprinkler irrigation disposal system might be the logical solution.

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Certainly this is not an all inclusive list of the situations SCS technical assistance can be used. We need to make an inventory and analysis of existing and potential areas where farm waste disposal may be a problem. We would, of course, first have to determine what kinds of conditions to inventory. The inter-agency sponsored roadside erosion inventory was a great deal of help in program development. A similar inventory on farm waste problems would seem to have merit.

In summary I would like to point out that technical assistance is available from SCS to help on farm waste disposal problems, under the following limitations:

1. Where the solutions involve techniques of soil and water conservation,

2. With the priorities established from time to time by local soil and water conservation district supervisors, and

3. Within the limitations of man-power available.

COST-SHARING UNDER THE AGRICULTURAL CONSERVATION PROGRAM

Kenneth H. Hoover*

In its original conception the Agricultural Conservation Program (ACP) was established to share with farmers the cost of establishing soil and water conservation practices on farmland. A few years ago Congress agreed that the objectives of the program could be broadened to include cost-sharing on farmland for practices designed primarily to enhance wildlife habitat. The 1970 ACP, again by agreement with Congress, can include practices for air and water pollution abatement as their primary purpose provided such practices also result in soil and/or water conservation.

It is this new pollution abatement authority under ACP in which this conference is interested. Before looking at it in more detail, there are some general provisions of ACP which we should mention and keep in mind. To be eligible to receive cost-sharing, an individual must be an agricultural producer. In order for a practice to be eligible for cost-sharing, it must be performed on farmland. An individual can receive no more than $2500.00 per program year on all his farm holdings in the United States. The only exception to this maximum payment limitation occurs when practices are performed under a "pooling agreement". A pooling agreement can be used when two or more producers contribute to, and their land benefits from, a practice which could not be completed without their working together. When a pooling agreement is involved, the maximum payment limit is $10,000.00 per individual for an agent type agreement or a total of $10,000.00 for the entire pooling agreement project if it is a manager type agreement.

The approval of ACP applications for cost-sharing, the disbursement of payments earned and the management of program funds is assigned to ASC County Committees for administration. The Agricultural Stabilization and Conservation Service (ASCS) is not a technical agency. Technical service for ACP practices is assigned to the Soil Conservation Service and the Forest Service working in cooperation with Wisconsin Department of Natural Resources (DNR) Forestry Division. Other divisions of this department also furnish technical services on certain ACP practices on an informal basis.

All state and federal agencies dealing with conservation, play an important part in formulating annually the state and county AC Programs. The Wisconsin ACP Development Group met on October 27 to formulate the 1970 Wisconsin AC Program. County ACP Development Groups met during the first two weeks of November to formulate 1970 county AC Programs.

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The Wisconsin ASC Committee, which is made up of three farmers, recognizes that it is important for agricultural agencies to make a realistic assessment of the problems of farm-based pollution and to take measures to abate such pollution. Now that new authority has been given under ACP to deal with these problems, the state committee has set aside some cost-sharing funds in a state reserve to accelerate pollution abatement practices. They have asked county ASC committees to set aside reserves from their county allocations of cost-sharing funds to be used for this purpose. The state committee cautions, however, that, as we work on pollution abatement, we must not lose sight of:

- the fact that anti-sedimentation practices, which have for years been promoted by ACP as well as by other agricultural agencies, have and are contributing a great deal toward pollution abatement.

- the danger of public misunderstanding of the degree to which farming is responsible for water pollution as opposed to pollution caused by other segments of our economy whose problems in this respect they believe are much more grave than those of agriculture.

- the fact that we must proceed with advice and assistance to farmers in animal waste handling only on the basis of sound and adequate research.

At the October 27 meeting of the Wisconsin ACP Development Group, it was pointed out that the broadened authority of ACP for pollution abatement practices is conditioned by the requirement that "such practices may include only those which provide soil and water conservation benefits..." in addition to their primary purpose of helping to abate soil, water or air pollution.

After considerable discussion the group listed components that ought to be included in pollution abatement cost-sharing practices, including:

- fence changes (relocation of barn yards, feedlots and lanes)
- diversions
- waterways
- grading - fills or cuts
- lagoons
- manure storage
- protecting stream crossings
- effluent holding ponds and use for irrigation

It was agreed that one practice should be drawn up to cover the first four components of this list and that the cost-sharing level should be 80% of cost.

It was agreed that we should seek approval to pay cost-sharing for construction of cattle crossings in connection with our present practice for streambank improvement with cost-sharing at 80% of cost.

It was agreed that a practice should be drafted providing cost-sharing for antipollution lagoons and ponds at 80% of cost.

It was agreed that approval should be sought for a manure storage pilot practice for the Lake Mendota watershed on the same basis as such a pilot practice has been proposed in previous years.

This action of the Development Group and the action the state ASC committee has taken to provide for cost-sharing funds to be held available for pollution abatement practices are first steps.

We now need to consult with state and federal agricultural and conservation agency technical personnel to draw up the practice specifications.

Following the drafting of the practices, it will be necessary to obtain the approval of the Washington office of ASCS where sister agency expertise will also be drawn upon in considering and approving or disapproving our proposals. We are in no position to predict whether our Development Group recommendations will be approved, approved with modifications or disapproved. We do know that in the past we have been unable to obtain recognition of our argument that protection of water quality is indeed water conservation. Recognition of this principle is probably necessary before we can obtain approval of the proposed manure storage pilot practice for the Lake Mendota watershed.

Practices for which approval is obtained will be incorporated in 1970 county AC Programs at the discretion of county AC Development groups.

It will then be the responsibility of all of our agencies to promote the use of these practices by farmers. Without farmer acceptance and financial contribution we obviously cannot accomplish our objectives.

THE REGULATORY ROLE OF THE DEPARTMENT OF NATURAL RESOURCES

Thomas G. Frangos*

The basic statutory authority for Wisconsin water pollution abatement is contained in Section 144.025 of the Wisconsin Statutes. Applicable sections of this statute are:

> "144.025 - The Department of Natural Resources shall serve as the central unit of state government to protect, maintain and improve the quality and management of the waters of the state, ground and surface, public and private. A comprehensive action program directed at all present and potential sources of water pollution whether home, farm, recreational, municipal, industrial or commercial is needed to protect human life and health, fish and aquatic life, scenic and ecological values and domestic, municipal, recreational, industrial, agricultural and other uses of water. The purpose of this act is to grant necessary powers and to organize a comprehensive program under a single state agency for the enhancement of the quality management and protection of all waters of the state, ground and surface, public and private. To the end that these vital purposes may be accomplished, this act and all rules and orders promulgated pursuant thereto shall be liberally construed in favor of the policy objectives set forth in this act. In order to achieve the policy objectives of this act, it is the express policy of the state to mobilize governmental effort and resources at all levels, state, federal and local, allocating such effort and resources to accomplish the greatest result for the people of the state as a whole.
>
> "The department shall have general supervision and control over the waters of the state.
>
> "The department shall adopt rules setting standards of water quality to be applicable to the waters of the state, recognizing that different standards may be required for different waters or portions thereof.
>
> "The department may issue general orders, and adopt rules applicable throughout the state for the construction, installation, use and operation of practicable and available systems, methods and means for preventing and abating pollution of the waters of the state. Such general orders and rules shall be issued only after an opportunity to be heard thereof has been afforded to interested parties.

* Administrator, Environmental Protection Division
Wisconsin Department of Natural Resources

"The department may issue special orders directing particular owners to secure such operating results toward the control of pollution of the waters of the state as the department prescribes, within a specified time.

"The department may issue temporary emergency orders without prior hearing when the department determines that the protection of the public health necessitates such immediate action."

Most pollution abatement has been aimed at solving problems that already exist. One piece of legislation aimed at prevention is Section 144.555:

"Report of Intended New Waste. Any industry which intends to increase the quantity of industrial wastes discharging to the surface waters of the state or to discharge a new waste to said waters or which intends to alter an existing outlet or build a new outlet for the industrial wastes shall, before starting such work, advise the department of resource development in writing concerning its intentions and supply the department with a general report describing steps which shall be taken to protect the surface waters of the state against new pollution or an increase in existing pollution. The report shall be submitted not less than 30 days before approval is desired, and no construction work shall be started until the report has been approved."

This section has been interpreted to include feedlot operations if they are of such a size and location as to cause water pollution.

Section 29.29(3) is useful for enforcing sporadic discharges into streams:

"Deleterious Substances. No person shall cast, deposit, or throw overboard from any boat, vessel or other craft into any waters within the jurisdiction of the state...or throw or deposit into any waters within the jurisdiction of the state ...any...substance deleterious to game or fish life other than authorized drainage and sewage from municipalities and industrial or other wastes discharged from mines or commercial or industrial or ore processing plants or operations, through treatment and disposal facilities installed and operated in accordance with plans submitted to and approved by the department of resource development under chapter 144, or in compliance with orders of that department. Any such order shall be subject to modification by subsequent orders. Any person violating any provision of this subsection may be fined not less than $10 nor more than $200 or imprisoned not more than 30 days or both."

This section is enforced by conservation wardens and violation results in an almost immediate fine. It could be brought into play if animal wastes were deposited in or near a stream.

Based on these statutes, it is clear that we have adequate authority to implement a program of pollution abatement aimed at any source of pollution. In addition to the above statutes, we also administer the shoreland management program which regulates land use within 1,000 feet of lakes and 300 feet of streams. Although the state standards do not spefically require regulation of animal grazing or spreading of manure, it is possible that these standards could be raised at a future date or that local ordinances could be made more stringent.

At the present time, the Department of Natural Resources has a minimum of activity directed at regulating water pollution from farm manure. However, our stream surveys, which in the past considered only municipal and industrial wastes, now include farm feedlots located near streams. If a survey shows water pollution is taking place from a feedlot, pollution abatement orders will be issued to the owner.

In view of the broad powers and duties assigned to the department, a logical question is, "Why aren't we doing more to regulate farm wastes?" There are three points which should be mentioned in this respect:

1. <u>Tradition</u> - Municipal and industrial wastes were the major concern of our predecessor agencies, and these will continue to be our major concern until such time as higher degrees of treatment are attained statewide. It has been a matter of first things first.

2. <u>Procedures</u> - Our basic regulatory tool is the order system. Orders issued against polluters may allow from a few months to several years for compliance, depending on the type of facility required. Although this method is effective against major waste sources, it becomes slow, cumbersome and difficult to administer if applied to a large number of minor polluters.

3. <u>Lack of Staff and Funds</u> - With our present staff and budget, we can barely sustain our existing programs. It isn't possible to add a major new program at this time without damaging our existing programs.

These points demonstrate priorities as we see them at this time. As we control the more obvious sources, more attention will be given to controlling diffuse waste sources such as farm wastes. However, there is an additional reason for not carrying out an enforcement program at this time. The fact is, there simply is not sufficient documented information on damages to water quality, sources of damage and feasible management alternatives for farmers to justify a major regulatory program at this time. When and if such information becomes available, existing legislation is already available to implement such a program.

If after careful study and consideration, such as is taking place at this conference, it appears that a regulatory approach either by itself or in conjunction with other programs is the best method, the Department of Natural Resources would be the logical state agency to implement such a program. It appears to me at this time that the powers and duties covered

in Section 144.025(2) (c) are adequate to justify an administrative code which would specifically apply to farm animal wastes. It could precisely specify what practices would be allowed or prohibited. It could be as specific as to specify distances which manure should be kept from streams, maximum slopes upon which manure could be spread, or any other criteria or standard which would be appropriate.

Before you get the impression that this would be a simple task, let me add several important precautionary statements. First, the rules must be based on "practicable and available systems." At this time, I'm not convinced that there are sufficiently practicable and available alternative systems to enable us to require significant modifications of current farm practices.

Secondly, the rules cannot be adopted without public hearing. Presumably, at this hearing, we would have to justify that (1) there is significant degradation of water quality, (2) there would be sufficient benefits to justify the increased costs required of the farmers and (3) the requirements are somewhat equitable with requirements imposed on other segments of industry or society.

Although we all intuitively know that farm wastes contribute to water pollution, this type of judgment falls far short of the hard data needed to insure a sound and fair regulatory program.

The other major obstacle is the cost of implementing a regulatory program that would require some surveillance of the 118,000 farms covering 21,000,000 acres of land in Wisconsin. At best, this would be an awesome task and, unless there is general public acceptance of the requirements, it would very likely be an impossible task.

Any solution to a problem as complex as the one we are dealing with will not rely on a single, simple, straight-forward approach. Rather, it will involve a mix of programs, combining regulation, research, education, financial assistance, voluntary actions by landowners and possibly even tolerance on the part of the non-farm population. My emphasis today has been to try and develop what I see as the proper perspective for the regulatory approach in relation to other types of solutions. I hope that as a result of this conference we can as a group more clearly understand which alternative courses of action should be followed.

COLUMBIA COUNTY PROGRAM

Joe Tuss*

Research on abatement of pollution from farm livestock is a major project in most states with high livestock populations. Emphasis on clean air, clean water and, in general, clean environment is what the public is demanding, and rightly so, as they view the deterioration of our environmental quality.

Gone are the days when people considered odors the smell of prosperity. As the populace becomes more city-oriented, they also become more antagonistic toward pollution from agriculture production. As a result agriculture must prove factually how much they contribute to pollution and abate this pollution as efficiently and quickly as possible.

We are in a critical stage in our agricultural production program. Accusing fingers are pointing at us in agriculture to do something about the clogged ditches, foul air and polluted waters. In Columbia County, farm neighbors and rural-oriented residence owners are complaining about the foul odor caused by spreading liquid manure and about animal wastes being washed across roadways onto their property.

Feedlots and dairy farm lots are designed to drain away from the feeding area and the buildings to keep the lot dry. At one time dispersing animal wastes over several acres caused no problem, but today in Columbia County, as in other counties, livestock is concentrated in smaller units. We pride ourselves for packing 500 head within a given area, but we have found no satisfactory answer for removing animal wastes. This problem is complicated by several months of freezing temperatures.

We have received complaints asking the agricultural or zoning committee to stop the spreading of liquid manure. We have received complaints about animal wastes being washed into road ditches and onto other property. We have received complaints from farmers about underground water supplies being contaminated by excessive in-place irrigation of Canning Processing Liquid Wastes.

But on the other hand we have farmers who are concerned about urbanization and subdivision development of agricultural lands within an intensified agricultural area. They do not want to be suppressed by complaints of livestock wastes or runoff. They want to do the right thing now, rather than be faced with costly changes in the future.

Because of this the County Zoning Ordinance was changed to prohibit the development of subdivisions in an agricultural district without a

* Agricultural Agent and Chairman, Columbia County Office, University Extension

hearing before the zoning committee for land use district change.

To take into account potential problems that could arise from livestock and agricultural waste, the Agricultural Committee of Columbia County charged the Columbia County Extension Service to formulate a 15-man farmer committee consisting of beef, hog and dairy farmers, specialized crop producers and agricultural products processing representatives. The committee will study the present situation in view of pending proposed requirements of animal and agricultural waste disposal. It will make recommendations for preventing agricultural pollution in current problem areas and in expanding agricultural enterprises.

Another area of concern is the nitrate in sub-surface water supplies in the rural areas. A joint program by Columbia County Health Services, Zoning Administration and the University Extension formulated a project to sample well water for nitrates. The project was stimulated by a farmer who surmised that his problem of aborted calves might be due to nitrates. He did have a very high nitrate nitrogen reading.

To date over 800 wells have been sampled. The information requested in addition to sampling was distance of the well from livestock yards, barns, buildings, or drainfields. We also asked for the depth of the well, the casing and the water level; for the kind of well, whether drilled, dug or sand point; and for the date of installation. We had no past history to work on since this was the first test for nitrates ever made on a large scale. We appreciate the cooperation of the Private Water Supply Section of DNR and the State Sanitary Division. The 4-H clubs assisted with the program.

At the outset, whenever high levels of nitrate nitrogen were found the Health Nurse checked to see if there were any pregnant women in the area. If so, water was transported from another source for home consumption, generally from a well of a village or city.

All of the wells sampled were charted on a large map of Columbia County. Three categories were delineated by different colored pins depicting wells with nitrate nitrogen levels of 0-10 mg/l, 11-20 mg/l, and 21 mg/l and above.

We found the most serious problems existed in areas of high livestock concentration. We have no real proof that this concentration is the source of the problem, but 43% of our high nitrate problem is on farms with high concentration of livestock. We also found that shallower wells had higher nitrate levels.

Farmers are concerned. Several new wells have been installed, according to the standards set forth, which are deeper and have more casing.

I see no need in reviewing charts and graphs that have been developed to show the varied conditions under which high nitrate level is apparent. We are attempting to cross reference with several factors to reach some sort of a conclusion.

At best we can say that there is correlation between livestock concentration and nitrate levels. Further, we are establishing a benchmark as to present levels of nitrates. We have found the people of Columbia County receptive to this program, but we do not have the answers.

I would like to see a state-wide emphasis on this program. This would mean enlarging facilities to take care of testing as well as personnel, but the health of our people and our livestock is most important and needs consideration. If nothing else, we did prove that many of our water from wells are far too high and excessive in nitrates and that this is a public health problem and needs more emphasis.

These are some of the items of concern to us in Columbia County, and they are no different than in any other Wisconsin county. We want a healthy environment and the sooner we get at it, the easier it will be to overcome the problems and meet the public's demand for clean air, water and environment.

WHAT ARE THE PROBLEMS IN WALWORTH COUNTY?

James Johnson*

Walworth County is located in the center of an area referred to by developers as the "Golden Triangle", an area bordered by Chicago, Milwaukee and Madison. As one of the fastest urbanizing regions in the nation, it can truly become a "golden" opportunity to the land speculator. The seven southeastern counties of Wisconsin can expect to experience between 1963 and 1990 the same amount of growth that occurred during the past 120 years. This means one million more people, 520,000 additional cars and 200 square miles of rural lands converted to urban uses.

Our land is thus shrinking. We must use each acre more carefully, as pressures increase for all uses of land. Basic land use conflicts are already occurring. A classic example is a small rural community just north of Elkhorn. Several new houses with "city-oriented" occupants have been built around the existing farms. Hardly a week goes by without a complaint from the neighbors about the "fragrance" of the feed lot next door. How long will it be before the "city people" outnumber the farmers and restrict all farm operations in an area best suited for permanent agriculture?

Walworth County is rather unique in southeastern Wisconsin with its numerous lakes, kettle moraine landscapes and environmental corridors greatly enhancing the overall environment. But this attractive environment makes us especially susceptable to Chicago's urban growth. It is estimated that 50% of our tax base is lake-oriented. We now find our invaluable water resources deteriorating at an alarming rate.

For example, Lake Delavan has experienced eutrophocation in the form of excessive algal blooms and siltation to seriously interfere with recreational activities, and thus depreciate property values. Who is to blame? All parties concerned assure us that it is the other fellow. We know, however, that all sources of nutrients are the culprits. Farm runoff and city sewage effluents are as responsible as the local streets, lawns and septic systems around the lake.

We are faced with a serious dilemma in Walworth County. Much of our urban development exists around our lakes, and this development occurred long ago under substandard regulations. We desperately need public water and sewer facilities to combat sanitation and public health problems. But new facilities invite, and often demand, more intensive development — the type that causes more nutrient runoff in the watersheds. Our solution to one problem thus aggravates our pollution problem.

* County Zoning Administrator, Walworth County
Elkhorn, Wisconsin

Adding to this problem is the trend toward concentration of farm operations. A farmyard with 100 chickens becomes a commercial operation with 20,000 birds. Concentrated feed lots are found on most farms today. These larger, more intensified farms multiply the risk of pollution from this source by as many farms as are in existence.

COUNTY PROGRAMS AND REGULATIONS

The Regional Plan, properly implemented, will regulate growth in such a way as to prevent many problems before they occur. The protection of environmental corridors through protective zoning, for instance, will insure proper use of many critical lands and will protect the resources of our basic watersheds. Residential encroachment into farmlands can be checked with "exclusive" agricultural zoning, allowing residential growth adjacent only to existing developments or where public facilities are available. All new growth in agricultural areas could then be regulated by determinations based on the public good, rather than by speculators making land use decisions on the basis of highest profits. Residential development should be balanced with commercial and industrial growth, and industrial development can be in the form of "smokeless industries" to blend with the aesthetic character of Walworth County.

The new Walworth County Sanitary Ordinance was a pioneering effort in pollution control which regulated urban growth through the use of soil surveys. Many thought this idea was too progressive. But we have survived and succeeded in accomplishing the intended purposes of the Ordinance, and we now see many others experiencing the same success. We have learned that we have much authority in abating pollution in the form of health and sanitation problems. Successful legal actions against such violators are well-documented in previous court cases.

But it is much more difficult to prosecute violators contributing only nutrients to waters because there is a lack of legal precedent on which to base a case. Since most law suits are fought and won on previous cases, ordinances regulating farm animal wastes need very careful enforcement. Much private and public education should be a part of the daily administration. Test cases for prosecution must be well-selected, and it should be obvious to the general public that the violators are pollutors. We recently issued orders for a chicken farm operator to discontinue the direct discharge of liquid manure into a stream. All the fish were dead for a mile down stream. Yet, prosecution in this case would have required detailed evidence and expert testimony on the toxicant, water quality deterioration, etc. Even though the Statute might "read" with much authority, successful pollution abatement comes with much education and reasonable enforcement.

NEW ZONING REGULATIONS

Regional Planners are recommending another new concept for our land use regulations in an attempt to control erosion and nutrient pollution through County Zoning. Our Ordinance will define this new concept as "County Conservation Standards", such standards to be all of the recommended conservation practices described in the Soil Conservation Service

Technical Guide. These standards will be adopted, by reference, in our Ordinance.

Problem areas requiring special treatment because of potential erosion or pollution, such as floodplains, shorelands, steeplands, erodable lands or areas with limited soil capabilities, all require farming to be conducted "in accordance with County Conservation Standards".

The new standards are as flexible as the technical guide, offering several solutions to each problem, and are therefore a reasonable approach. Likewise, our definitions of feedlots, steeplands, etc. are general enough to allow flexible and reasonable enforcement.

Some new zoning districts will also be helpful in preventing animal waste problems. Exclusive agricultural districts will help separate conflicting residential and farm uses. Special "upland conservancy" or "estate residential" districts will allow limited development on environmental corridors while protecting soil and water resources. Planned development districts will concentrate growth in such a way as to help preserve open-space lands so that good farms can continue farming.

EDUCATION ESSENTIAL

In grass-roots government, local people generally end up with the type of regulations they really want. The educational program, person to person and group to group, can thus greatly determine the creativeness and effectiveness with which the new land use programs can deal with the problems. Much can be accomplished with local regulations, but only with enlightened citizens.

We have been meeting with many civic groups for more than a year. An especially effective group has been our "Farm Council", an advisory committee representing all farm organizations in the county. Their strong support of our proposals is very encouraging. If all landowners were as aware and civic-minded as this group, passage of the Ordinance would be assured. This group is now helping us sell the Ordinance to others.

Zoning, by Statute, is a joint County-Township Ordinance, requiring both County and Town Board approval. Most town boards are still farm-oriented. The town boards, therefore, become a doubly important group to work with in establishing new regulations. They are not only necessary for adoption of regulations but can do much to sell others on the program.

ROLE OF UNIVERSITY EXTENSION

Gale Vandeberg*

A basic premise upon which this country was established and has prospered is that "education makes a difference". University Extension, whose mission is education for all who are not attending a regular on-campus college program, has modified that slogan to "Extension makes a difference".

One thing that has always seemed apparent in this country is that whenever a large number of people become concerned about an issue or a need to bring about change — when they become concerned enough to organize, learn the facts necessary for decision making, and then agree on a course of action — change takes place. Let me illustrate the process.

An issue ---> education ---> organization (mobilization) --->

education ---> decision making ---> action.

These are the functions for which Cooperative (agricultural) Extension in all state land-grant colleges and universities was established and for which most adult education emanating from universities is aimed.

As a result of organized group action, Wisconsin residents have:

- a brucellosis free state
- a sheep scabies free state
- artificial breeding cooperatives
- zoning regulations
- community hospitals, clinics, doctors
- industrial development corporation, park, new industry
- financing for farmers
- erosion control on farms

We can list scores of such examples. Look again at the terms involved in bringing about change.

An issue ---> education ---> organization --->

education ---> decision making ---> action.

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University of Wisconsin, Madison

Were they all involved in the kinds of changes I listed? Of course! And behind the education and in support of it must be adequate research, or the education will have no base except experience, and the decision and actions may be less than the best.

At this conference we have dealt with an issue, "farm animal waste disposal", and we have learned some things about the issue and helped to clarify it. And there are some organized groups learning more, making decisions and taking action. The question is what further needs to be done, research-wise, organizationally, educationally and action-wise.

I find, in examining the conference program, there are some 25 University Extension faculty involved, many of whom are also researchers. There are several more research faculty and numerous individuals from other related agencies who have information and resources for focusing on the issue of these two days. All of us are involved in extending our respective agencies and institutional resources toward decisions and action relative to the issue.

As representatives of various agencies and institutions at this conference, we have gained additional insights and more common insights into the issue of animal waste management. We have learned what information and technical assistance is available among us.

Obviously, a major division of University Extension for which I am responsible, the Division of Economic and Environmental Development, has a central concern and staff resources for the environmental and economic aspects of animal waste management. Included among these resources are specialists in seven departments of the College of Agricultural and Life Sciences (agricultural engineering, agricultural economics, soil science, dairy science, meat and animal science, poultry science, and wildlife ecology). In addition, there are the staff in our soil and water conservation unit and our water resources unit.

Beyond this division, there are staff in the Extension engineering department, the College of Engineering, the Madison Campus Water Resources Center, and staff in all of the county Extension offices throughout the state. When you add to all these the technical, financial and regulatory resources of other state and federal agencies represented here, I think I am justified in saying, "If we can clarify what should be done, we have or can get the resources to do it."

The primary goals of county and state Extension faculty are (1) to increase people's understanding of facts, new knowledge and the methods of applying those facts and (2) to help people use technical and financial resources designed to bring about desired results — change.

There are several clientele types that various departments must consider in planning educational and demonstration programs from their particular department. Some must focus on the dairy farmer, some on feedlot operators, some on large poultry producing enterprises, some on processors, some on government officials and some on the public in general.

University Extension staff are not in a position to formulate the policies or to promote any particular political scheme for animal waste control. But we do have the responsibility to help various groups and the public to understand the problems and the alternatives; to help people who need to organize for action to do so; and to help groups and individuals to know what they can do, how to do it, and what resources are at their disposal. Likewise, Extension staff have the responsibility to feed into the various departments additional research needs relative to this issue.

We, as agency and institutional representatives, have been smart enough in the past to pool our efforts and resources toward common goals. Our very presence here suggests we will do so on this issue. Surely, if we put together the educational, technical and regulatory functions in mutual support, we can provide enough understanding and assistance to bring about voluntary changes in the matter of animal waste disposal in this state, or any other.

Just as we are getting rapid and alarming increases in human waste, from sewerage to old cars, and a concentration of that waste in small areas where population is piling up, so too the agricultural industry is rapidly concentrating wastes in small areas -- dairy cattle herds of 50 to 100 instead of 15 to 20, sometimes on very few acres; huge feedlots for feeder cattle and hogs; mammoth poultry production units; giant animal and animal product processing plants of all kinds. It is this very concentration, this new system of agriculture, that demands new systems for disposal of waste and management of by-products.

People throughout the country are showing increasing concern for the quality of our environment and the effects of pollution on it. Until recent years, pollution was excused as a component of industrialization and a part of the price for progress and the abundance of material goods. People deep in the ghettos and people in the hinterlands, as well as national leaders of all interests, are fast coming to the conclusion that if this is the price of progress, it is too great; indeed, that unabated pollution may destroy the abundance it helped to create.

Nearly all who have studied the problem and some who haven't offer solutions. Some are entirely too simple and too "pat." There is no "pat" solution. Pollution cannot be defined with physical or idealistic boundaries in a way that permits a single individual, group or agency to deal with it as an entity separate from our normal everyday activities.

The key to maintaining an environment that is pleasing and healthful lies in adding the environmental quality dimension to all our recreational, social and productive activities. This means that every decision must be tempered by the question, "How will this operation or activity, its product, by-products, and wastes affect the quality of our environment?" Only in part can this question be answered by edict or decree. Rather, it is a matter of broad and continuous education. Herein lies the challenge to Extension.

WHERE DO WE GO FROM HERE?

Richard H. Vilstrup*

It is extremely difficult to summarize briefly the excellent comments, ideas and presentations made at this conference. We are very pleased with the participation and cooperation of the agencies involved. Many conclusions can be drawn from the speeches and the "new idea" sessions.

This conference has identified some critical problems and needs in the waste management field. Likewise, several promising opportunities and potential programs have been suggested. Some excellent research, educational and service programs have been started.

Several key agencies are concerned about waste management problems and are willing to assist farmers and processing plants. Participants have suggested that we encourage the use of existing agencies that have done some outstanding foundation work in the past. It appears there is need for expanded communication and interchange of information between groups vitally interested in these problems.

Waste management problems have many dimensions. These dimensions are environmental, social, economic, physical, political and psychological. The terms used in this field frequently have different meanings. We need to write acceptable definitions of terms if we want to successfully coordinate programs among the various interested groups.

Most participants agree there is an increasing concern for the quality of environment in Wisconsin. The state has a strong agricultural base and its leaders are trying to provide the best possible environment for all industries and activities. Problems must be put in perspective and conditions must be maintained, so that agriculture can provide the quality and variety of food for the consumer.

Although the current tendency is to emphasize disposal, waste management specialists in the future will be more concerned about utilization. There seems to be a concensus that the problems of agriculture production will increase. Animal production will be more concentrated, specialized and mechanized in an expanding industrialized and urbanized community. Wisconsin's animal agriculture will grow and continue to provide an important economic base in the future. There is a vital need for more research, demonstrations and education in this waste management field. New funds and support will be needed to adequately provide the answers and programs for the future. Research and education are needed on such things as: waste, technology, regulations, legislation, odor, health, economics, environment, processing, utilization, zoning, water, runoff, soils, mechanization, labor-saving devices and barnyard design.

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We need to be constantly alert to new ideas and programs in other areas. More efficient transference of technology throughout the country is essential. We cannot afford to duplicate our efforts. We can best profit by the helpful experience of others concerned about these problems. We need to attack emerging problems and move ahead to new solutions and recommendations.

Environmental problems are complex and will require team action. Programs will be designed on an interdisciplinary basis with close cooperation between the physical and social sciences.

As Dean Pound and John Skinner pointed out, we will need the courage to make some hard choices, set vital priorities and consider carefully consequences of our actions as we chart our paths in this important field.

Specific Recommendations

Well, where do we go from here? The committee has received many suggestions and recommendations. These are:

1. That the inter-agency planning committee be encouraged to continue to meet on waste management problems. That they consider expanding the committee to include representation from industry and farmers.

2. That the Animal Waste and By-Product Management Conference be continued annually. That the next conference focus on new techniques for solving problems.

3. That the agencies interested in waste management put together a "brief" publication outlining the functions, resources and staff available in this field. That they identify the specific person to be contacted for initial assistance from the agency or institution.

4. That we need a Comprehensive Public Affairs Educational Program dealing not only with rural, but urban and suburban waste problems as well.

5. That the committee identify problem areas and evaluate the need for specialized conferences and seminars (example: a conference on the Nitrate Problem).

The educational committee recommended that (1) programs on waste disposal and utilization be identified as a major educational priority for action, (2) a comprehensive project and program be developed to such funding and support in the next biennium to handle this problem in agriculture and (3) a package program, including research, demonstration and technical information and methods, be put together with existing material from all agencies, to be distributed to leaders at the county level.

BREAKFAST DISCUSSION GROUPS

Dairy Manure Handling Problems

F.H. Buelow, T.J. Brevik, J.W. Crowley, W.J. Werth

Our group discussed a number of dairy manure handling problems and came up with several suggestions that can improve the situation.

Problems

- Yard drainage. As barnyard paving increases in size, there is no plan for water movement after it leaves the concrete. The slope of the yard is also often wrong; drain and cows go in the same direction.

- Odors. As animal concentrations increase, odor becomes a greater problem.

- Animal health. What happens to disease organisms in stored manure?

- Commercial fertilizers. They may be as great a source of pollution as manure.

- Farmer's labor. It is now valued at only $1.50 per hour.

- Water pollution (manure runoff). How close to streams should we farm? How close should we spread manure?

- Stacking. How do we best control flies, odors and drainage. How do we stack most efficiently? Can we stack year around? Are our "grade A" regulations reasonable in relation to the changing programs?

- Liquid manure. Odor control, cost and land availability are the big problems here.

- Soil runoff. We're losing ground as far as soil conservation practices are concerned because of changing practices and more intensified use of land. Land well-treated with manure will have less runoff.

- Public agencies are not working together, and regulations and guidelines are inconsistent.

Solutions

- Utilize the manure in various ways rather than disposing of it. Find out how much manure is really worth. Our feeling is manure has a much greater value than that of N.P.K. It's more than $1.40 per ton.

- We must find definite figures on the kinds of slopes on which manure can be spread and under what conditions it should be spread.

- Soil Conservation Service needs to work up recommendations for practices, based on soil type for use in developing farm plans for manure handling.

- More cost-sharing practices are needed on an 80-20 basis.

- An extensive educational program for farmers is needed with all agencies working together. We may need to change the philosophy of manure handling.

- More guidelines are needed for stacking manure handling.

- Ag Economics needs to up the value of farmer's labor.

Other comments

- We need another conference--this one was excellent.

- Regional planning groups for land use are needed.

- We need to stay ahead of rules and regulations with more education.

- We need to broaden this committee--include farmers and others.

- The University needs to come up with more answers so we can stay ahead.

- The farmer needs to demonstrate that he is trying. He needs the help of others.

###

Dairy Manure Handling Problems

E.G. Bruns, R.P. Niedermeier

Guidelines for liquid manure handling and free stall barns are examples of a cooperative effort that have given nation-wide guidance to all concerned with farm waste management. These guidelines have been circulated nation-wide and hopefully they will influence unification of codes, etc. on a national basis.

Currently, a need exists for guidelines for calf and heifer housing and for careful attention to consistency between different species of livestock; i.e., dairymen are not permitted to use concrete stave pits for liquid manure but hog farmers can. The Department of Natural Resources needs to become active in guidelines and provide rules for pollution control. We should develop rules and guidelines to make possible more definitive answers to waste management. Guidelines are really the basis of ideas and do not provide for new ideas. For example, we need to ask why slotted floors are not permitted in the holding area of milking parlors.

Surface disposal research is badly needed. Guidelines are also needed regarding this area. This includes a need for cooperation between those working with the dairyman and those concerned with pollution and zoning regulations. Another needed research area is the use of additives to control odors.

Currently, there are a multitude of rules and codes, developed by regulatory agencies, concerned with health standards and pollution control on dairy farms. There is a need to unify and consolidate regulations. Regulatory agencies should be urged to tell the dairyman what he can do as well as what he can't do.

The need for research on dairy farm waste management is apparent. Unfortunately, too much of the work now being done in this area is "bootlegged" research. Obviously, a good offense is the best defense and research is needed to back up development of constructive, new ideas and programs for waste management.

There is dire need for information on disposal systems. Should dairymen plan on one system, such as liquid or solid manure, or use a two system approach? The North Dakota system for surface effluent disposal is a recent new development that might have merit in this area.

There is also a need to strive for consistency in codes between agencies as well as between communities and states. One inconsistency is that a Wisconsin dairyman can install a resident sewage system according to Wisconsin regulations, which require a septic tank distance from the well of 25 feet, and still not comply with USPHS bluebook regulations, which require 50 feet.

###

Farm Waste Handling -- Grade A Milk

E. Wallenfeldt - Clarence Luchterhand

Our group discussed manure stacking vs. hauling on Grade A dairy farms. We feel we have made great gains sanitation-wise in hauling manure to fields. Farm members feel that they can regulate hauling to the field to avoid runoff. They feel dairy farmers can be educated to regulate hauling in rolling areas to prevent runoff. Dairy farmers say we are destroying a sound practice.

We agree that it is difficult enough to control flies; we see no reason why other factors should be added to an already significant problem. There is also an esthetic factor that should not be overlooked as far as our Wisconsin markets are concerned. A distinction should be made between dairy farms and other types of farm operations, i.e., beef, swine and poultry. We do not think stacking should be adapted to a Grade A dairy farm as a year around operation. We feel there is inadequate information available at this time to allow stacking on Grade A farms.

However, in view of the statements pro and con on manure stacking, we do feel a study of manure stacking should be made by the College of Agricultural and Life Sciences along with the Wisconsin Committee on Dairy Cattle Housing. Entomologists, engineers and dairy farmers should be brought into the picture by the committee. The study should begin as soon as possible. If it shows stacking has merit, it would seem advisable to develop guidelines as in Free Stall Housing, Liquid Manure, etc.

Sanitarians are definitely for any developments that will save labor and improve animal waste disposal systems to minimize pollution. Sanitarians at the same time have the responsibility for making sure that sanitation and public health in general is safeguarded where any system is used. Sanitarians do have many reservations about some of the methods proposed and very emphatically stress the importance of adequate research evidence to assure that public health and milk quality is safeguarded under practical conditions.

Such research evidence supported by entomologists, bacteriologists, dairy production specialists, engineers, farmers as well as food scientists and other sanitarians is needed before general approval can be expected.

###

Feedlot Management

R. J. Vatthauer

Our group discussed several ways to correct or improve many of the problems connected with feedlot manure handling.

- Zone to prevent subdivisions from encrouching upon agricultural installations and vise versa.

- Create buffer zones.

- Determine legal implications of subdividing areas marginal in acceptable environment for people; could limitations be imposed on the amount of complaints allowed in these marginal areas?

- Determine the kinds of manure handling that work best on various soil types.

- Use $(NH_4)_2NO_3$ at 10#/1000 gal. of liquid to check odor.

- Educate public on the necessity of livestock production with its associated odors, wastes, etc. for economical food production.

- Develop regulations for runoff control from lots and yards to control contamination of surface groundwater.

- Control starling and pigeon population between outside lots and yards.

- Establish guidelines for rates of manure application/acre for various soil types.

- Establish guidelines for suggested manure handling systems under given set of conditions, herd size, land type, topography, location of town, etc.

- Determine what environmental factors need to be considered for each type system.

###

Swine Manure Handling Problems

C.L. Barth, F.J. Giesler

The discussion touched on a variety of specific problems which are now of primary concern. Several suggestions were made to help correct these problems.

- Determine acceptable procedures for the handling of all classes of livestock wastes. Study manure collection procedures, compare manure handling as a solid and as a liquid, and refine field application techniques.

- Determine ways to control odors associated with confinement housing of livestock and field spreading manure.

- Determine the degree of influence of animal agriculture on erosion and sedimentation.

- Determine the importance of pollution caused by sedimentation.

- Be aware of legislation to control procedures for disposal of livestock wastes.

- Determine the influence waste disposal has on the economics of livestock enterprises.

- Consider using new methods to dispose of animal wastes: (1) disposal of wastes on public property, (2) processing wastes for further utilization and (3) use of lagoons for storage and treatment.

The following points were suggested for consideration in future meetings and as further activities of a state-wide farm waste handling committee.

- Concentrate on solutions to one or a few specific problems.

- Emphasize the relationship between waste disposal and land use planning (zoning).

- Establish standing committees in each livestock discipline to be responsible for program guidance.

- Develop recommendations for minimum acreage allowances for livestock operations.

- Look to the efforts of other states and organizations who have faced and attacked similar farm waste problems.

###

Poultry Manure Handling Problems

H.R. Bird, L.C. Arrington, J.L. Skinner

Our group discussed several steps that could be taken to help correct the problems associated with large poultry operations.

- By-Product Evaluation -- Feeding litter to cattle, as opposed to considering it waste.

  Extensive work has been done on this in several areas. Questions that must be considered are:

  1. Is there a need to consider different litter materials from the standpoint of their nutritional value?

  2. Which of the possible litter materials would make the most economical cattle feeds?

  3. Where should poultry operations be located in relation to cattle operations that can use the litter? Should they both be on same farm?

  4. If recycling becomes a trend, will poultry go back toward floor operations?

  Odor is a real problem. In most locations, there are enough people who can use and want the manure, but it is difficult to get it to them. Odors are released each time manure is disturbed, as in (1) cleaning out the house, (2) hauling to the field and (3) spreading. As any of these operations generate more residues, trouble results.

- Manure Dryers (dehydrators)

  The major problem here is expense due partially to high maintenance requirement. Manures are quite corrosive, which makes necessary periodic replacement of parts or use of expensive stainless steel equipment. What is the odor from a dehydrator? Or incinerator? Afterburners will reduce this problem, but this is an added expense.

- Lagoons

  Lagoons require considerable management if odor is to be controlled. They must also be cleaned out occasionally, unless they are very large.

- Land use planning

  Plan locations of poultry operations in areas with proper buffer zones around them. This will protect the poultryman from encrouching residents. Buffer zones of cropping can be used around concentrated animal production areas. Some areas have "green belt acres" -- land areas with restrictions which tend to limit its use to agriculture.

- Land use controls

Licensing farming operations to control numbers of animals in a given area may need to be considered. The licensing program must consider the proposed operation, location, etc. to protect both the applicant and the community. It must keep city build-up away from high-concentration animal operations.

The group recommends better coordination between all agencies involved in zoning, building regulation, pollution control, health, and other agencies for improved, long-range planning.

###

Technical Assistance to Farmers as Part of Soil and Water Conservation Plans

Jack Densmore, Wm. Briggs

Our group is greatly concerned with public health aspects. There is an increase of diseases spread through contaminants of feed and water. The problem applies to urban and rural areas alike. Dust, construction and run-off from city lots, streets and roads within cities all contribute to the problem. Much research and many answers are still needed for all phases of this problem, including costs and returns. Suggestions for improving the situation include:

- Use animal manures to help save the cost of additional fertilizers. This should be done even though nutrients are not as important as they used to be (cost).

- Consider using chemicals to eliminate odors offensive to the public.

- Ask local industry and all public service agencies to work together to solve the problems. Joint community action is needed.

- Consider including regulations for farm animal waste disposal in zoning and land use ordinances. These two regulatory devices will have an effect on the future of agriculture in Wisconsin.

- Encourage inventories and studies on a small watershed basis on all related problems. This will help us come up with better criteria.

- Make use of cropping and conservation practices that can help with the problem, such as:

  -- Grass waterways. Establish wide, tough waterways to help serve as a filter.

  -- Cover crops. Use more cover crops on land normally left bare in winter months.

  -- Buffer strips (e.g., sudan grass). Use more often to filter out manure before drainage reaches water courses.

  -- Use terracing, strip cropping, contouring, diversions and crop residues.

  -- Limit amounts of nitrogen to the amount needed by crops. The more oats and meadow in the rotation the less residual nitrogen.

  -- Spread manure on hayfields or grain stubble rather than open fields.

  -- Plant woody screens of shrubs or trees to reflect odors.

- Incorporate the plan for disposal of manure into conservation plans. Alternatives could be included. Include cost-sharing. Local county money is needed since the problem affects local people.

- Keep feedlots and barnyards out of waterways. Construct underground culverts or divert present run-off from existing feedlots or barnyards.

- Consider the use of roof or covering over manure piles. Use gutters on buildings that drain directly into feedlots or barnyards. Consider greater use of diversions around barnyards and feedlots.

Other comments:

- There remains a great need for interdisciplinary study of the problem.

- Can research come up with a material or catalyst that can be mixed with manure so that it will "tie up" the nitrogen and potassium and other possible pollutants until the ground thaws in the spring?

- After we get more answers, training sessions will be needed in smaller areas.

- A real fine session -- well planned and well attended.

###

Water Quality Standards

T. Frangos, W. Kerr, J. Cain

Water quality standards give us a basis for determining what water quality we should maintain in any given stream. A major problem of relating rural pollution to the water quality standards is that the sources are very diffused and it is difficult to take legal action against a large number of relatively minor polluters.

The main basis for regulatory action at this time appears to be against major polluters where water quality degradation is obvious. Water quality standards should serve as a basis for planning as well as for regulatory action. They serve to identify critical areas where action is needed and to point the way to the development of a high quality environment, including water, land and air.

###

ASCS Cost-Sharing Possibilities and Needs

R.J. Penn, K. Hoover

Recognition must be given to the principle that protection or improvement of water quality is water conservation.

High cost-sharing on practices for pollution abatement that greatly benefit the public is more justified than cost-sharing on practices that benefit, in large measure, the individual performing them.

Proponents of pilot cost-sharing projects for expensive manure storage systems should examine the availability of federal funding from the Department of Health, Education and Welfare, the U.S. Department of the Interior and the U.S. Department of Agriculture. It is possible that a multiple-agency pilot effort could be made in the Lake Mendota watershed, for example.

###

Nitrates in Wells and Ground Waters

L.M. Walsh, C.L.R. Holt, G.W. Lawton

Our group suggested several steps and programs that can help correct the nitrate problem.

- Establish a program to sample all wells in problem areas under controlled conditions; i.e., standardize sampling techniques, collection of data on well construction, geology, etc.

- Determine animals health standards for nitrates. Also establish standards for adults and re-evaluate the 10 ppm NO_3-N level for infants.

- Establish research programs to define more precisely the source of nitrates in ground and surface waters.

- Establish a program to determine the "age" of the water in wells so as to find out when the water became contaminated.

- Establish a program to determine ways of improving the efficiency of nitrogen fertilizers and manures.

- Determine the effect of feedlots, septic tank drainage fields and other areas where high levels of nitrates accumulate locally on adjacent wells.

- Separate short-range considerations from long-range considerations.

- Improve public relations. Refrain from publishing undocumented, speculative statements which confuse and "scare" the public and may "stampede" legislative groups into passing unwise, restrictive and perhaps costly legislation.

###

Lake and Stream Pollution From Manure

O.J. Attoe, D.R. Keeney

The discussion covered a wide variety of aspects of lake and stream pollution. It was generally felt that the farmer is the key man who needs to be informed of the problems and advised of better methods. The approach would have to be educational. There are too many different conditions and people involved to try and handle all cases by regulations. Some of the steps and programs that should be encouraged are:

- Develop, through education, an awareness of the problems or those that may occur and steps that might be taken to mitigate them. We should not wait for new research data before putting into practice the things we already know are needed.

- Use what manure and fertilizer the crop and soil can utilize but don't overdo it. Soil testing and realistic yield goals are the basis for correct application rates.

- Use selective manuring and fertilization with respect to slope, soil, frozen ground, crops, watercourses and precipitation to minimize run-off.

- Use good conservation practices to limit run-off--grassed waterways, terraces, diversions, contour farming, crop rotation and soil stabilization.

- Incorporate pollution prevention with conservation and subsidy programs to obtain financial assistance.

- Limit the direct access of farm animals to watercourses. This can be accomplished by land or easement purchase, cost sharing for fencing and crossings, and possibly by zoning.

- Provide alternate disposal methods and areas for such contingencies as blizzards, extreme cold weather, spring break-up and equipment failure.

- Use zoning to restrict the encroachment of urban areas onto farmlands and the development of urban "islands" in farm areas. Because of aesthetics and possible nuisances, these could restrict what might otherwise be considered good manure handling and disposal practices.

- Use zoning to limit high farm animal populations in the immediate vicinity of oligotrophic lakes.

###

Educational Programs Needed on Waste Disposal

A.J. Francour, H.L. Ahlgren

There is a definite need for research, short and long range planning and program development. Programs need an established priority, special funding and state legislative support and action. Our group made several suggestions concerning the development of educational programs:

- Develop waste disposal educational programs based on all research available. Do not limit the programs to farm animal waste.

- Establish a task force representing all agencies and individuals to move with this problem.

- Design educational programs for the total public not just rural areas.

- Research special waste problems thoroughly and develop educational programs to counter the problem.

- Establish sanitary codes that contain waste disposal regulations and fit into county zoning regulations. Design educational programs for municipalities and public officials.

- Develop an educational program showing needs and indicating the need for financial assistance through federal and state sources.

- Establish FHA grants for rural waste similar to urban water and sewer grants.

- Identify an agency to research the problem, an agency to present educational programs and an agency to carry out action programs.

###

Stream Water Quality and Manure

W. Threinen, E.F. McCoy

Stream problems have equally diverse causes. Problems mentioned during the discussion included (1) fertilization from animal sources (including humans) and erosion sources, (2) nitrification of organic soils, (3) actual fish kills from toxicants and (4) erosion of banks from motorboats. Mobility of nitrogen in an oxidized form is the most serious difficulty noted at present. There is a great loss of nutrients in association with sediments, so soil erosion control is important.

The basic solution to the misplaced fertility problems is to bring the nutrients in contact with soils and plants rather than surface waters. An objective of water quality standards should be to keep nutrient levels and BOD levels low. In many places there is inadequate fertility. In other places, fertility is excessive to the point of plugging up streams with aquatic plant growths and causing local oxygen depletion.

Since preliminary reports on movement of fertilizers in conjunction with soil is apparently much more than originally visualized or anticipated, soil erosion control appears vital. Animal wastes have both high BOD and nutrient quantities, so their entry into streams must be avoided. Feedlots and lanes subject to considerable erosion would be chronic sources.

A provoking question asked was, 'Why don't Japan and the Netherlands have serious fertilization problems when they fertilize at ten times the rate of Wisconsin fertilization?" The question wasn't adequately answered.

As for solutions, water quality standards offer a basis for action against those affecting surface waters. Using care in locating people and activities can avoid many problems, but it is not being done extensively. Taxation policies that tend to direct activities could be much more widely used. For example, forest lands are taxed at low rates; why also not flood plains and stream banks, which may be chronic sources of erosion with intensive land use? Fencing incentives have been employed to some extent. Discrete acquisition of public lands for open space and stream bank protection would be valuable and has been practiced by the Department of Natural Resources.

There are no single solutions. Consideration of the whole watershed is necessary.

###